ALMANAC FOR COMPUTERS

for the year

1978

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Section A: EXPLANATION

Introduction

The *Almanac for Computers* has been designed to facilitate the application of digital computers and small calculators to problems of astronomy and navigation which require coordinates of celestial bodies. For such applications the fixed-interval tabulations of the *American Ephemeris and Nautical Almanac (AE)*, the *Nautical Almanac (NA)* and the *Air Almanac (AA)*, with the inevitable requirement of interpolation, should ideally be replaced by concise mathematical expressions for direct calculations. Such expressions must take the form of mathematical approximations, however, since the precise data contained in the above publications are calculated from extensive theories which are not readily adaptable to the majority of astronomical and navigational applications. Using the expressions in this almanac, it is possible to calculate, with minimal loss of precision, the basic data in the *AE, NA* and *AA* for specific times and conditions. More specific information on precision is given in Tables 1, 2, 3 and 4 of this section.

While retaining the basic approach of the previous edition, changes in the format and contents should make this edition somewhat easier to use and generally more useful than its predecessor. Improvements in the current edition are directly attributable to the large body of constructive criticism from users of the previous edition. Unfortunately some very sound suggestions have not been implemented, simply because it was not practicable to include them this year. With further time for development, they may be used in future editions.

In Section E of this edition we provide expressions for extended time spans. The trigonometric series in this section were developed by T. C. Van Flandern and K. F. Pulkkinen of the Nautical Almanac Office, who offer them here in advance of full publication.

For most efficient use with computers, the data in Sections D and F and the Chebyshev series in Section E are available on punched cards or magnetic tape.

Continued improvements in the *Almanac for Computers* will depend on further input from users. Inquiries, suggestions and comments should be sent to the Director, Nautical Almanac Office, U. S. Naval Observatory, Washington, D. C. 20390.

CALENDAR, 1978

Day of Month	JANUARY			FEBRUARY			MARCH			APRIL		
	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year
	2443			2443			2443			2443		
1	509.5	Sun.	1	540.5	Wed.	32	568.5	Wed.	60	599.5	Sat.	91
2	510.5	Mon.	2	541.5	Thu.	33	569.5	Thu.	61	600.5	Sun.	92
3	511.5	Tue.	3	542.5	Fri.	34	570.5	Fri.	62	601.5	Mon.	93
4	512.5	Wed.	4	543.5	Sat.	35	571.5	Sat.	63	602.5	Tue.	94
5	513.5	Thu.	5	544.5	Sun.	36	572.5	Sun.	64	603.5	Wed.	95
6	514.5	Fri.	6	545.5	Mon.	37	573.5	Mon.	65	604.5	Thu.	96
7	515.5	Sat.	7	546.5	Tue.	38	574.5	Tue.	66	605.5	Fri.	97
8	516.5	Sun.	8	547.5	Wed.	39	575.5	Wed.	67	606.5	Sat.	98
9	517.5	Mon.	9	548.5	Thu.	40	576.5	Thu.	68	607.5	Sun.	99
10	518.5	Tue.	10	549.5	Fri.	41	577.5	Fri.	69	608.5	Mon.	100
11	519.5	Wed.	11	550.5	Sat.	42	578.5	Sat.	70	609.5	Tue.	101
12	520.5	Thu.	12	551.5	Sun.	43	579.5	Sun.	71	610.5	Wed.	102
13	521.5	Fri.	13	552.5	Mon.	44	580.5	Mon.	72	611.5	Thu.	103
14	522.5	Sat.	14	553.5	Tue.	45	581.5	Tue.	73	612.5	Fri.	104
15	523.5	Sun.	15	554.5	Wed.	46	582.5	Wed.	74	613.5	Sat.	105
16	524.5	Mon.	16	555.5	Thu.	47	583.5	Thu.	75	614.5	Sun.	106
17	525.5	Tue.	17	556.5	Fri.	48	584.5	Fri.	76	615.5	Mon.	107
18	526.5	Wed.	18	557.5	Sat.	49	585.5	Sat.	77	616.5	Tue.	108
19	527.5	Thu.	19	558.5	Sun.	50	586.5	Sun.	78	617.5	Wed.	109
20	528.5	Fri.	20	559.5	Mon.	51	587.5	Mon.	79	618.5	Thu.	110
21	529.5	Sat.	21	560.5	Tue.	52	588.5	Tue.	80	619.5	Fri.	111
22	530.5	Sun.	22	561.5	Wed.	53	589.5	Wed.	81	620.5	Sat.	112
23	531.5	Mon.	23	562.5	Thu.	54	590.5	Thu.	82	621.5	Sun.	113
24	532.5	Tue.	24	563.5	Fri.	55	591.5	Fri.	83	622.5	Mon.	114
25	533.5	Wed.	25	564.5	Sat.	56	592.5	Sat.	84	623.5	Tue.	115
26	534.5	Thu.	26	565.5	Sun.	57	593.5	Sun.	85	624.5	Wed.	116
27	535.5	Fri.	27	566.5	Mon.	58	594.5	Mon.	86	625.5	Thu.	117
28	536.5	Sat.	28	567.5	Tue.	59	595.5	Tue.	87	626.5	Fri.	118
29	537.5	Sun.	29				596.5	Wed.	88	627.5	Sat.	119
30	538.5	Mon.	30				597.5	Thu.	89	628.5	Sun.	120
31	539.5	Tue.	31				598.5	Fri.	90			

The Julian Day begins at noon.

Day of Month	MAY Julian Date at 0^h	MAY Day of Week	MAY Day of Year	JUNE Julian Date at 0^h	JUNE Day of Week	JUNE Day of Year	JULY Julian Date at 0^h	JULY Day of Week	JULY Day of Year	AUGUST Julian Date at 0^h	AUGUST Day of Week	AUGUST Day of Year
	2443			2443			2443			2443		
1	629.5	Mon.	121	660.5	Thu.	152	690.5	Sat.	182	721.5	Tue.	213
2	630.5	Tue.	122	661.5	Fri.	153	691.5	Sun.	183	722.5	Wed.	214
3	631.5	Wed.	123	662.5	Sat.	154	692.5	Mon.	184	723.5	Thu.	215
4	632.5	Thu.	124	663.5	Sun.	155	693.5	Tue.	185	724.5	Fri.	216
5	633.5	Fri.	125	664.5	Mon.	156	694.5	Wed.	186	725.5	Sat.	217
6	634.5	Sat.	126	665.5	Tue.	157	695.5	Thu.	187	726.5	Sun.	218
7	635.5	Sun.	127	666.5	Wed.	158	696.5	Fri.	188	727.5	Mon.	219
8	636.5	Mon.	128	667.5	Thu.	159	697.5	Sat.	189	728.5	Tue.	220
9	637.5	Tue.	129	668.5	Fri.	160	698.5	Sun.	190	729.5	Wed.	221
10	638.5	Wed.	130	669.5	Sat.	161	699.5	Mon.	191	730.5	Thu.	222
11	639.5	Thu.	131	670.5	Sun.	162	700.5	Tue.	192	731.5	Fri.	223
12	640.5	Fri.	132	671.5	Mon.	163	701.5	Wed.	193	732.5	Sat.	224
13	641.5	Sat.	133	672.5	Tue.	164	702.5	Thu.	194	733.5	Sun.	225
14	642.5	Sun.	134	673.5	Wed.	165	703.5	Fri.	195	734.5	Mon.	226
15	643.5	Mon.	135	674.5	Thu.	166	704.5	Sat.	196	735.5	Tue.	227
16	644.5	Tue.	136	675.5	Fri.	167	705.5	Sun.	197	736.5	Wed.	228
17	645.5	Wed.	137	676.5	Sat.	168	706.5	Mon.	198	737.5	Thu.	229
18	646.5	Thu.	138	677.5	Sun.	169	707.5	Tue.	199	738.5	Fri.	230
19	647.5	Fri.	139	678.5	Mon.	170	708.5	Wed.	200	739.5	Sat.	231
20	648.5	Sat.	140	679.5	Tue.	171	709.5	Thu.	201	740.5	Sun.	232
21	649.5	Sun.	141	680.5	Wed.	172	710.5	Fri.	202	741.5	Mon.	233
22	650.5	Mon.	142	681.5	Thu.	173	711.5	Sat.	203	742.5	Tue.	234
23	651.5	Tue.	143	682.5	Fri.	174	712.5	Sun.	204	743.5	Wed.	235
24	652.5	Wed.	144	683.5	Sat.	175	713.5	Mon.	205	744.5	Thu.	236
25	653.5	Thu.	145	684.5	Sun.	176	714.5	Tue.	206	745.5	Fri.	237
26	654.5	Fri.	146	685.5	Mon.	177	715.5	Wed.	207	746.5	Sat.	238
27	655.5	Sat.	147	686.5	Tue.	178	716.5	Thu.	208	747.5	Sun.	239
28	656.5	Sun.	148	687.5	Wed.	179	717.5	Fri.	209	748.5	Mon.	240
29	657.5	Mon.	149	688.5	Thu.	180	718.5	Sat.	210	749.5	Tue.	241
30	658.5	Tue.	150	689.5	Fri.	181	719.5	Sun.	211	750.5	Wed.	242
31	659.5	Wed.	151				720.5	Mon.	212	751.5	Thu.	243

The Julian Day begins at noon.

CALENDAR, 1978

Day of Month	SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year
	2443			2443			2443			2443		
1	752.5	Fri.	244	782.5	Sun.	274	813.5	Wed.	305	843.5	Fri.	335
2	753.5	Sat.	245	783.5	Mon.	275	814.5	Thu.	306	844.5	Sat.	336
3	754.5	Sun.	246	784.5	Tue.	276	815.5	Fri.	307	845.5	Sun.	337
4	755.5	Mon.	247	785.5	Wed.	277	816.5	Sat.	308	846.5	Mon.	338
5	756.5	Tue.	248	786.5	Thu.	278	817.5	Sun.	309	847.5	Tue.	339
6	757.5	Wed.	249	787.5	Fri.	279	818.5	Mon.	310	848.5	Wed.	340
7	758.5	Thu.	250	788.5	Sat.	280	819.5	Tue.	311	849.5	Thu.	341
8	759.5	Fri.	251	789.5	Sun.	281	820.5	Wed.	312	850.5	Fri.	342
9	760.5	Sat.	252	790.5	Mon.	282	821.5	Thu.	313	851.5	Sat.	343
10	761.5	Sun.	253	791.5	Tue.	283	822.5	Fri.	314	852.5	Sun.	344
11	762.5	Mon.	254	792.5	Wed.	284	823.5	Sat.	315	853.5	Mon.	345
12	763.5	Tue.	255	793.5	Thu.	285	824.5	Sun.	316	854.5	Tue.	346
13	764.5	Wed.	256	794.5	Fri.	286	825.5	Mon.	317	855.5	Wed.	347
14	765.5	Thu.	257	795.5	Sat.	287	826.5	Tue.	318	856.5	Thu.	348
15	766.5	Fri.	258	796.5	Sun.	288	827.5	Wed.	319	857.5	Fri.	349
16	767.5	Sat.	259	797.5	Mon.	289	828.5	Thu.	320	858.5	Sat.	350
17	768.5	Sun.	260	798.5	Tue.	290	829.5	Fri.	321	859.5	Sun.	351
18	769.5	Mon.	261	799.5	Wed.	291	830.5	Sat.	322	860.5	Mon.	352
19	770.5	Tue.	262	800.5	Thu.	292	831.5	Sun.	323	861.5	Tue.	353
20	771.5	Wed.	263	801.5	Fri.	293	832.5	Mon.	324	862.5	Wed.	354
21	772.5	Thu.	264	802.5	Sat.	294	833.5	Tue.	325	863.5	Thu.	355
22	773.5	Fri.	265	803.5	Sun.	295	834.5	Wed.	326	864.5	Fri.	356
23	774.5	Sat.	266	804.5	Mon.	296	835.5	Thu.	327	865.5	Sat.	357
24	775.5	Sun.	267	805.5	Tue.	297	836.5	Fri.	328	866.5	Sun.	358
25	776.5	Mon.	268	806.5	Wed.	298	837.5	Sat.	329	867.5	Mon.	359
26	777.5	Tue.	269	807.5	Thu.	299	838.5	Sun.	330	868.5	Tue.	360
27	778.5	Wed.	270	808.5	Fri.	300	839.5	Mon.	331	869.5	Wed.	361
28	779.5	Thu.	271	809.5	Sat.	301	840.5	Tue.	332	870.5	Thu.	362
29	780.5	Fri.	272	810.5	Sun.	302	841.5	Wed.	333	871.5	Fri.	363
30	781.5	Sat.	273	811.5	Mon.	303	842.5	Thu.	334	872.5	Sat.	364
31				812.5	Tue.	304				873.5	Sun.	365

The Julian Day begins at noon.

Navigational Tables

Section C contains mathematical representations of the following functions that are tabulated in the *Nautical Almanac (NA)*: the GHA of Aries, the GHA and declination of the Sun, Moon and navigational planets, the semi-diameter of the Sun and Moon, and the horizontal parallax of the Moon. These functions are expressed for a specified time span by a power series of the form

$$f(x) = a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + a_5x^5$$

In the series x is a time-like variable which takes on values between -1 and $+1$ over the specified time span; $a_0, a_1, a_2, a_3, a_4, a_5$ are coefficients which are tabulated in Section C for the specified time span; and $f(x)$ represents the value of the function (*e.g.*, the GHA of Aries) evaluated at time x.

To evaluate the series for one of the navigational functions, one must first find the set of coefficients in Section C that is applicable for the desired date. Constants A and B are given there for the purpose of converting the calendar date and GMT to the time-like variable x. To obtain the value of x for the desired time, first determine t, the GMT measured in days and fractions thereof from 0 January, 0^h GMT, from the relation $t = N + \mathrm{GMT}/24$, where N is the day of the year at Greenwich and GMT is the Greenwich Mean Time expressed in hours. A calendar is provided on pages A2–A4 for finding the day of the year; alternatively the day of the year can be computed from the following formula, valid for 1978 and other non-leap years:

$$N = \left\langle \frac{275M}{9} \right\rangle - 2\left\langle \frac{M+9}{12} \right\rangle + I - 30$$

where M is the month number and I is the day of the month. The angular brackets indicate that the integral part of the enclosed quantity is to be taken. (See the Applications Section (Section B) for a fuller explanation of this and other formulas for computing the day of the year.) Once t has been determined, x is computed from the relation $x = t/A + B$. If computed correctly, the value of x should fall in the range $-1 \leqslant x \leqslant +1$.

Example: Compute x for later use in computing the position of the Sun at $15^h 22^m 00^s$ GMT ($=0^d.6402778$) on 2 November 1978.

From the calendar on page A4, 2 November is found to be day 306; alternatively, substituting $M = 11$ and $I = 2$ in the formula given above yields

$$N = \left\langle \frac{275 \cdot 11}{9} \right\rangle - 2\left\langle \frac{11+9}{12} \right\rangle + 2 - 30 = 336 - 2 \cdot 1 + 2 - 30 = 306$$

Thus $t = 306 + 0.6402778$.
This date is in the interval 1 November through 2 December (days 305 through 336) for which coefficients for the Sun are given on page C6. The constants for this interval are $A = 16.0$ and $B = -20.0625$. Therefore
$x = 306.6402778/16.0 - 20.0625 = -0.8974826$.

Once the variable x has been computed and the coefficients a_i have been found, the series $f(x) = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + a_4 x^4 + a_5 x^5$ can be evaluated. The series can be evaluated most efficiently by computing a set of five auxiliary variables, b_1, b_2, b_3, b_4, b_5, in the following order:

$$\begin{aligned}
b_5 &= x a_5 \\
b_4 &= x(a_4 + b_5) \\
b_3 &= x(a_3 + b_4) \\
b_2 &= x(a_2 + b_3) \\
b_1 &= x(a_1 + b_2) \\
f(x) &= a_0 + b_1
\end{aligned}$$

By using this algorithm, the series is evaluated in its nested form $f(x) = a_0 + x(a_1 + x(a_2 + x(a_3 + x(a_4 + x a_5))))$.

Example: Compute the GHA of the Sun at $15^h 22^m 00^s$ GMT on 2 November 1978.

From the previous example $x = -0.8974826$.
The coefficients for the Sun's GHA may be found on page C6.

$$\begin{aligned}
b_5 &= -0.8974826(0.0043) &&= -0.0039 \\
b_4 &= -0.8974826(0.0172 - 0.0039) &&= -0.0120 \\
b_3 &= -0.8974826(0.0055 - 0.0120) &&= +0.0058 \\
b_2 &= -0.8974826(-0.4531 + 0.0058) &&= +0.4014 \\
b_1 &= -0.8974826(5759.2528 + 0.4014) &&= -5169.1895
\end{aligned}$$

$f(-0.8974826) = 5943.7871 - 5169.1895 = 774^\circ\!.5976$
Therefore GHA $= 54^\circ\!.5976 = 54^\circ 35'\!.9$

Note that when computing the GHA, it may be necessary to reduce the final result to the range $0^\circ - 360^\circ$ by subtracting multiples of 360°.

Example: Compute the declination of the Moon at $03^h 15^m 30^s$ GMT on 22 May 1978.

The constants A and B and the series coefficients are found on page C14.
$x = 142.1357639/3.0 - 47.3333333 = +0.0452546$

$b_5 = 0.0452546\,(-0.1251) \qquad = -0.0057$
$b_4 = 0.0452546\,(-0.1789 - 0.0057) \qquad = -0.0084$
$b_3 = 0.0452546\,(1.2985 - 0.0084) \qquad = +0.0584$
$b_2 = 0.0452546\,(4.0308 + 0.0584) \qquad = +0.1851$
$b_1 = 0.0452546\,(-8.3716 + 0.1851) \qquad = -0.3705$
$f(0.0452546) = -14.8136 - 0.3705 \qquad = -15^{\circ}.1841$
declination $= -15^{\circ}11'.0$

Although the series are designed to provide precision comparable to that published in the *NA*, there will be small discrepencies between the tabulated values and the values computed from the series. In such cases it should be understood that the *NA* represents the standard. Table 1 lists the largest discrepencies found from evaluating and comparing the series with the data in the *NA*.

Under no circumstances should the series be used to extrapolate data beyond the specified time interval. Such extrapolation will lead to erroneous and useless results.

In accordance with standard practice for navigational almanacs, the time argument used in this almanac is Greenwich Mean Time (GMT), or more specifically UT1. To obtain full precision in the determined positions, the radio time signals in UTC must be corrected to UT1, or GMT, according to standard procedures. (See the paper by R. L. Duncombe and P. K. Seidelmann, 'The New UTC Time Signals', *Navigation*, **24**, 160–165, 1977.)

Table 1: Comparison of *Almanac for Computers* with *NA*

Function		No. of Terms	Span of Validity	Maximum Error
GHA of Aries		6	32 days	0'.2
Sun:	GHA	"	"	0'.1
	Declination	"	"	0'.2
	Semi-Diameter	"	"	0'.1
Moon:	GHA	"	6 days	0'.2*
	Declination	"	"	0'.2
	Horizontal Parallax	"	"	0'.2
	Semi-Diameter	"	"	0'.1
Navigational Planets:	GHA	"	32 days	0'.2†
	Declination	"	"	0'.2†

*Except for the span 18–23 July, when the error in GHA may reach 0'.3.
†Except for Venus during November, when errors in GHA and declination may reach 0'.3.

Section D contains mathematical representations of data published in the *American Ephemeris and Nautical Almanac (AE)*. Chebyshev expansions have been chosen as the means of representation since they provide efficient and accurate expressions that can be easily evaluated with a small computer. The coefficients a_i of the Chebyshev expansion

$$f(x) = a_0/2 + \sum_{i=1}^{n} a_i T_i(x)$$

are tabulated for prescribed time spans, where $f(x)$ is the function being represented, $T_i(x)$ is the Chebyshev polynomial of the first kind of the *i-th* degree, and x is the normalized time variable. Although Chebyshev polynomials appear in the formal series expansions, the series can be evaluated without explicitly computing these polynomials. No *a priori* knowledge of Chebyshev analysis is required to use the series in this almanac. Interested readers can find information on Chebyshev analysis in *Applied Analysis* by C. Lanczos and *Chebyshev Polynomials in Numerical Analysis* by L. Fox and I. B. Parker.

It must be emphasized that the series are valid only over the specified time intervals. Attempts to extrapolate data using these series will yield erroneous and useless results.

An advantageous feature of approximations in Chebyshev series is that a reliable estimate can be made of the precision of the approximation. Using the full series as published will provide values of the astronomical functions to a precision comparable to that published in the *AE*. However, in the frequent cases in which values computed from the series differ slightly from the *AE*, it should be understood that the *AE* represents the standard. Table 2 lists the largest errors resulting from evaluating and comparing the full series with the data printed in the *AE*. If lower precision is sufficient, the series can be truncated according to the following precept to obtain shorter series with the desired precision. Beginning with the last coefficient, add the absolute values of the coefficients until the required limit of precision is accumulated. The series may be safely truncated at this point.

Example: Find the number of terms required to compute the apparent right ascension of the Sun to a precision of $\pm 1^s$ ($= \pm 0^h\!.00028$) during the period 1 July through 3 October 1978.

The required series coefficients are found on page D6. Summing the absolute values of coefficients 23 through 6 for the Sun's right ascension gives a total of $0^h\!.00023$; adding to this the absolute value of coefficient 5 increases the total to $0^h\!.00063$, which exceeds the limit of precision. Therefore terms 6 through 23 can be dropped safely, and terms 0 through 5 yield right ascensions to approximately $\pm 1^s$ during this period.

To evaluate the approximations, one must first normalize the time variable to the interval for which the series is valid. The normalized time x is determined from a relation of the form $x = t/A + B$, where values of A and B are given for

Table 2: Comparison of *Almanac for Computers* and *AE*

Function		No. of Terms	Span of Validity	Maximum Error
Apparent Sidereal Time at 0^h UT		36	95 days	$0\overset{s}{.}001$
Equation of the Equinoxes		"	"	$0\overset{s}{.}001$
Nutation in Longitude		"	"	$0\overset{\prime\prime}{.}009$
Nutation in Obliquity		"	"	$0\overset{\prime\prime}{.}005$
Sun:	Right Ascension	24	95 days	$0\overset{s}{.}01$
	Declination	"	"	$0\overset{\prime\prime}{.}1$
	Distance	"	"	2×10^{-7} AU
	Semi-Diameter	"	"	$0\overset{\prime\prime}{.}01$
	Ephemeris Transit	"	"	$0\overset{s}{.}01$
Moon:	Right Ascension	38	32 days	$0\overset{s}{.}002$
	Declination	"	"	$0\overset{\prime\prime}{.}02$
	Horizontal Parallax	"	"	$0\overset{\prime\prime}{.}01$
	Geocentric Rectangular Coods.	"	"	1×10^{-6} Earth radii
Mercury:	Right Ascension	40	95 days	$0\overset{s}{.}02$
	Declination	"	"	$0\overset{\prime\prime}{.}2$
	Distance	"	"	1×10^{-6} AU
Venus:	Right Ascension	40	95 days	$0\overset{s}{.}02$
	Declination	"	"	$0\overset{\prime\prime}{.}1$
	Distance	"	"	1×10^{-6} AU
Mars:	Right Ascension	22	95 days	$0\overset{s}{.}02$
	Declination	"	"	$0\overset{\prime\prime}{.}2$
	Distance	"	"	1×10^{-6} AU
Jupiter:	Right Ascension	22	95 days	$0\overset{s}{.}02$
	Declination	"	"	$0\overset{\prime\prime}{.}2$
	Distance	"	"	1×10^{-6} AU
Saturn:	Right Ascension	22	95 days	$0\overset{s}{.}02$
	Declination	"	"	$0\overset{\prime\prime}{.}2$
	Distance	"	"	1×10^{-6} AU
Uranus:	Right Ascension	22	95 days	$0\overset{s}{.}02$
	Declination	"	"	$0\overset{\prime\prime}{.}2$
	Distance	"	"	9×10^{-6} AU
Neptune:	Right Ascension	22	95 days	$0\overset{s}{.}02$
	Declination	"	"	$0\overset{\prime\prime}{.}2$
	Distance	"	"	8×10^{-6} AU
Pluto:	Right Ascension (astrometric)	22	95 days	$0\overset{s}{.}001$
	Declination (astrometric)	"	"	$0\overset{\prime\prime}{.}01$
	Distance	"	"	1×10^{-6} AU

each set of coefficients and t is reckoned in days and fractions thereof from 0 January. If correctly computed, the value of x will fall in the range $-1 \leqslant x \leqslant +1$.

For the functions Apparent Sidereal Time at 0^h UT, the Equation of the Equinoxes, Nutation in Longitude and Nutation in Latitude, the variable t is measured in days of Universal Time from 0 January, 0^h UT. For all other functions in Section D, t is measured in days of ephemeris time from 0 January, 0^h ET. These latter functions can be evaluated for Universal Times, however, by using the normalizing relation $x = (t' + \Delta T)/A + B$, where t' is the Universal Time measured in days from 0 January, 0^h UT. As this volume goes to press, $\Delta T = 49^s\!.3$ ($=0^d\!.000571$) appears to be a reliable value to use in 1978. Care should be taken to verify that the sum $t' + \Delta T$ falls within the time span for which the series is valid; if it falls outside, the series and constants for the next span should be used.

Once the normalized time variable x is determined, the approximation

$$f(x) = a_0/2 + \sum_{i=1}^{n} a_i T_i(x)$$

where the a_i are the printed coefficients, can be evaluated as follows:

let $\quad b_{n+1} = b_{n+2} = 0,$

compute $\quad b_i = 2xb_{i+1} - b_{i+2} + a_i, \quad$ for $i = n, n-1, \ldots, 0,$

then $\quad f(x) = (b_0 - b_2)/2.$

Example: Compute the apparent right ascension of the Sun to a precision of $\pm 1^s$ at $14^h 10^m 25^s$ ($=0^d\!.590567$) UT on 28 July 1978.

From the previous example we know that terms 0 through 5 must be carried to ensure the required precision on this date. Using the calendar (page A3) or the formulas on page B2, it is found that 28 July is day 209. Since the series for the solar coordinates are based on ephemeris time, it is necessary to add ΔT to the specified Universal Time. Therefore

$t = 209 + 0.590567 + 0.000571 = 209.591138$

On page D6 are found the constants for the time span: $A = 47.5$ and $B = -4.83157895$. Therefore

$x = 209.591138/47.5 - 4.83157895 = -0.419133939$

With this value of x and the coefficients from page D6, the algorithm works as follows:

$$\begin{aligned}
b_{n+2} &= b_7 = 0\\
b_{n+1} &= b_6 = 0\\
b_n &= b_5 = 2xb_6 - b_7 + a_5 = -0.0004006\\
& \quad\; b_4 = 2xb_5 - b_6 + a_4 = +0.0041015\\
& \quad\; b_3 = 2xb_4 - b_5 + a_3 = +0.0079027\\
& \quad\; b_2 = 2xb_3 - b_4 + a_2 = -0.0756807\\
& \quad\; b_1 = 2xb_2 - b_3 + a_1 = +3.0443100\\
& \quad\; b_0 = 2xb_1 - b_2 + a_0 = +16.9239355\\
f(x) &= (b_0 - b_2)/2 = (16.9239355 + 0.0756807)/2\\
\mathrm{RA} &= 8^h\!.4998081 = 8^h 29^m 59^s
\end{aligned}$$

Expressions for Extended Periods of Time

Section E contains reduced-precision mathematical representations of astronomical data, valid for extended periods of time. The expressions presented in this section are of two types: (1) Chebyshev series similar to those in Section D, but valid for all of the current year; and (2) trigonometric series, valid for the years 1800 through 2100, approximately. Although these representations are of lower precision than those contained in Section D, the precision is sufficient for many applications, including navigation and telescope pointing. Tables 3 and 4 list the maximum errors that may arise from using the data in Section E.

The Chebyshev series presented on pages E1–E4 represent the same astronomical functions as the series in Section D, except that series for the Moon's coordinates have not been included. For a description of Chebyshev series and their evaluation, see pages A8–A10.

The trigonometric series on pages E5–E21 were provided by Thomas C. Van Flandern and Kenneth F. Pulkkinen in advance of eventual publication as a Naval Observatory Circular. Included here are series for generating the apparent right ascension, declination and geocentric distance of the Sun, Moon, Mercury, Venus, Mars and Jupiter. In addition series are provided for the equatorial, rectangular coordinate and velocity components of the Sun, referred to the mean equator and equinox of 1950.0.

Evaluation of the trigonometric series is accomplished by computing the necessary fundamental arguments for the desired date, computing the value of each trigonometric term, and then summing the values of the individual terms. These steps should be carried out in the following manner:

(1) For the desired date and time, determine T, the interval in Julian Centuries from 0 January 1900, 12^h ET. This is obtained from the formula

$$T = (\text{JED} - 2415020.0)/36525$$

where JED is the Julian Ephemeris Date corresponding to the specified date and time. (A formula for computing Julian Dates is given in the Applications Section, page B2.) For dates before 1900, T will be negative.

(2) Using the expressions in Table 5, compute the values of the fundamental arguments G, L, A, C, N, *etc.*, as necessary (not all of the fundamental arguments are used in every series). It may be necessary or desirable to reduce these values to the range 0°–360°.

(3) Compute the value of each term in the series. The format of the trigonometric series is one term per line. Each term should be computed in the following manner:

(a) Compute the value of the expression within parentheses, comprised of the sum of integer multiples of the fundamental arguments. It may be necessary or desirable to reduce this value to the range 0°–360°.

Table 3: Precision of Chebyshev Series in Section E
(series are valid for year 1978 only)

Function		No. of Terms	Maximum Error
Apparent Sidereal Time at 0^h UT		14	$0^s.03$
Equation of the Equinoxes		"	$0^s.03$
Nutation in Longitude		"	$0''.4$
Nutation in Obliquity		"	$0''.2$
Sun:	Right Ascension	24	$0^s.6$
	Declination	"	$3''$
	Distance	"	$4 x 10^{-5}$ AU
	Semi-Diameter	"	$0''.05$
	Ephemeris Transit	"	$0^s.6$
Mercury:	Right Ascension	50	6^s
	Declination	"	$51''$
	Distance	"	$3 x 10^{-4}$ AU
Venus:	Right Ascension	50	$0^s.05$
	Declination	"	$0''.5$
	Distance	"	$2 x 10^{-6}$ AU
Mars:	Right Ascension	24	$0^s.7$
	Declination	"	$3''$
	Distance	"	$4 x 10^{-5}$ AU
Jupiter:	Right Ascension	24	$0^s.2$
	Declination	"	$0''.5$
	Distance	"	$4 x 10^{-5}$ AU
Saturn:	Right Ascension	24	$0^s.1$
	Declination	"	$0''.4$
	Distance	"	$4 x 10^{-5}$ AU
Uranus:	Right Ascension	24	$0^s.1$
	Declination	"	$0''.3$
	Distance	"	$5 x 10^{-5}$ AU
Neptune:	Right Ascension	24	$0^s.05$
	Declination	"	$0''.3$
	Distance	"	$5 x 10^{-5}$ AU
Pluto:	Right Ascension (Astrometric)	24	$0^s.02$
	Declination (Astrometric)	"	$0''.2$
	Distance	"	$4 x 10^{-5}$ AU

Table 4: Precision of the Trigonometric Series in Section E
(series are valid for years 1800–2100, approximately)

Function		Maximum Error
Sun:	X, Y, Z (equator and equinox of 1950.0)	$1\mathrm{x}10^{-4}$ AU
	$\dot{X}, \dot{Y}, \dot{Z}$ (equator and equinox of 1950.0)	$1\mathrm{x}10^{-5}$ AU/day
	θ, ϕ	$1\mathrm{x}10^{-4}$ AU
	ρ	$1\mathrm{x}10^{-4}$ AU^2
	Right Ascension (from θ, ρ, ϕ)	$0^{\mathrm{m}}.1$
	Declination (from θ, ρ)	$1'$
	Distance (from ρ)	$5\mathrm{x}10^{-5}$ AU
Moon:	θ, ϕ	0.01 Earth radii
	ρ	0.01 Earth radii^2
	Right Ascension (from θ, ρ, ϕ)	$0^{\mathrm{m}}.1$
	Declination (from θ, ρ)	$1'$
	Distance (from ρ)	$1\mathrm{x}10^{-4}$ Earth radii
Mercury, Venus, Mars:		
	θ, ϕ	$1\mathrm{x}10^{-4}$ AU
	ρ	$1\mathrm{x}10^{-4}$ AU^2
	Right Ascension (from θ, ρ, ϕ)	$0^{\mathrm{m}}.1$
	Declination (from θ, ρ)	$1'$
	Distance (from ρ)	$2\mathrm{x}10^{-4}$ AU
Jupiter:	θ, ϕ	$1\mathrm{x}10^{-3}$ AU
	ρ	$1\mathrm{x}10^{-3}$ AU^2
	Right Ascension (from θ, ρ, ϕ)	$0^{\mathrm{m}}.1$
	Declination (from θ, ρ)	$1'$
	Distance (from ρ)	$2\mathrm{x}10^{-4}$ AU

(b) Compute the indicated trigonometric function (sine or cosine), using the result from step (3a) as the argument.

(c) Multiply the result from step (3b) by the indicated coefficient, the numerical value at the left side of the line. Note that the coefficient may be either positive or negative.

(d) If the symbol T is present in the term, multiply the result from step (3c) by the value of T computed in step (1).

It should be noted that there may be one or two terms in a series with no trigonometric factor, *i.e.*, steps (3a) and (3b) cannot be performed. For such a term consider the results of steps (3a) and (3b) to have the value 1, and continue with step (3c).

(4) Sum all the values of the terms in the series. To obtain the highest numerical precision, begin with the terms of smallest absolute value; *i.e.*, sum the series from the bottom to the top.

Example: The following is a sample series similar to those found in Section E. Evaluate this series for 22^h05^m ET on 24 April 1978.

SAMPLE SERIES

	AU										
	0.732580		SIN (							L	)
-	0.004617		SIN (		G				-	2L	)
-	0.001068	T	COS (		4G	-	N		+	6L	)
+	0.000624										
+	0.000020		COS (	-	G	+	3N				)

The Julian Ephemeris Date for the desired epoch is JED = 2443623.4201; therefore $T = +0.78311896$. In the above series, only the fundamental arguments G, N and L are required. Their values for the desired epoch are computed from the expressions in Table 5:

$G = 110^\circ\!.0141$ $\qquad N = 184^\circ\!.5213$ $\qquad L = 32^\circ\!.5816$

Substituting the computed values of T, G, N and L, the series becomes:

$$
\begin{array}{lll}
0.732580 & & \times \sin(32^\circ\!.5816) \\
-0.004617 & & \times \sin(44^\circ\!.8509) \\
-0.001068 \times & 0.78311896 & \times \cos(91^\circ\!.0247) \\
+0.000624 & & \\
+0.000020 & & \times \cos(83^\circ\!.5498)
\end{array}
$$

Carrying out the indicated operations within each term, the series becomes:

$$0.394494 - 0.003256 + 0.000015 + 0.000624 + 0.000002$$

Summing these terms gives the value of the sample series for the desired epoch: 0.391879 AU.

If astronomical data of very low precision is sufficient, the Chebyshev and trigonometric series in Section E can be truncated according to the following precept. Take from Table 3 or 4, as appropriate, the listed error for the series of interest. Add to this value the absolute values of the coefficients of the series, beginning with the last term and working upward until the required limit of precision is accumulated. The series can be truncated at this point, and the small terms omitted.

The apparent right ascension, declination and geocentric distance of a body can be obtained from the trigonometric series for the quantities θ, ρ and ϕ. Once values of θ, ρ and ϕ have been computed, the apparent place is obtained from the relations

apparent right ascension: $\mathrm{RA} = l + \arcsin(\phi/\sqrt{\rho-\theta^2})$
apparent declination: $\mathrm{decl} = \arcsin(\theta/\sqrt{\rho})$
true geometric distance: $\Delta = \sqrt{\rho}$

where the principal value of the arcsine function ($-90°$ to $+90°$) should be used. For the Sun, Moon, Mars and Jupiter, l represents the mean longitude of the body on the desired date; for Mercury and Venus, l represents the mean longitude of the Sun on the desired date. Expressions for computing mean longitudes are given in Table 5.

Example: Compute the apparent geocentric coordinates of the Sun at 0^h ET on 7 October 1978.

The Julian Ephemeris Date for the desired epoch is JED = 2443788.500; therefore $T = +0.78763860$. The required series for the paramenters θ, ρ and ϕ are found on page E7. Evaluation of these series yields

$\theta = -0.0920$ $\rho = +0.9990$ $\phi = -0.0519$

In this case l is the mean longitude of the Sun, which is designated L in Table 5. Evaluating the expression in Table 5 yields $l = 195\overset{\circ}{.}2921$. Therefore

$\mathrm{RA} = 195\overset{\circ}{.}2921 + \arcsin(-0.0519/0.9953) = 192\overset{\circ}{.}3031 = 12^h 49^m 13^s$
$\mathrm{decl} = \arcsin(-0.0920/0.9995) = -5\overset{\circ}{.}2813 = -5°16\overset{'}{.}9$
$\Delta = 0.9995$ AU

Table 5: Fundamental Arguments of Trigonometric Series

Mean anomaly of the Sun:

$$G = 358^\circ\!.475833 + 35999^\circ\!.049750T - 0^\circ\!.000150T^2$$

*Mean longitude of the Sun:

$$L = 279^\circ\!.696678 + 36000^\circ\!.768920T + 0^\circ\!.000303T^2$$

Mean anomaly of the Moon:

$$A = 296^\circ\!.104608 + 477000^\circ\!.0T + 198^\circ\!.849108T + 0^\circ\!.009192T^2$$

*Mean longitude of the Moon:

$$C = 270^\circ\!.434164 + 480960^\circ\!.0T + 307^\circ\!.883142T - 0^\circ\!.001133T^2$$

*Longitude of the ascending node of the Moon's orbit:

$$N = 259^\circ\!.183275 - 1800^\circ\!.0T - 134^\circ\!.142008T + 0^\circ\!.002078T^2$$

Elongation of the Moon from the Sun:

$$D = 350^\circ\!.737486 + 444960^\circ\!.0T + 307^\circ\!.114217T - 0^\circ\!.001436T^2$$

Argument of latitude of the Moon:

$$B = 11^\circ\!.250889 + 483120^\circ\!.0T + 82^\circ\!.025150T - 0^\circ\!.003211T^2$$

Longitude of the Earth, equator and equinox of 1900.0:

$$E = 98^\circ\!.998753 + 35640^\circ\!.0T + 359^\circ\!.372886T$$

*For evaluation of the series for the Sun's equatorial, rectangular coordinate and velocity components ($X, Y, Z, \dot{X}, \dot{Y}, \dot{Z}$) referred to the equator and equinox of 1950.0, the expressions given above for the arguments L, C and N should be replaced by the following:

$$L = 279^\circ\!.696678 + 36000^\circ\!.76892T + 0^\circ\!.000303T^2 - p$$
$$C = 270^\circ\!.434164 + 480960^\circ\!.0T + 307^\circ\!.883142T - 0^\circ\!.001133T^2 - p$$
$$N = 259^\circ\!.183275 - 1800^\circ\!.0T - 134^\circ\!.142008T + 0^\circ\!.002078T^2 - p$$

In these expressions p is the precession in longitude from 1950.0 to the desired date; it can be computed from

$$p = [1^\circ\!.396041 + 0^\circ\!.000308(T + 0.5)](T - 0.499998)$$

(Table 5 continued on next page)

Table 5: Fundamental Arguments (continued)

Mean anomaly of Mercury:
$H = 102\overset{\circ}{.}279381 + 149400\overset{\circ}{.}0T + 72\overset{\circ}{.}515289T + 0\overset{\circ}{.}000007T^2$

Mean longitude of Mercury:
$K = 178\overset{\circ}{.}179078 + 149400\overset{\circ}{.}0T + 74\overset{\circ}{.}070778T + 0\overset{\circ}{.}000301T^2$

Argument of latitude of Mercury:
$F = 131\overset{\circ}{.}033133 + 149400\overset{\circ}{.}0T + 72\overset{\circ}{.}885569T + 0\overset{\circ}{.}000127T^2$

Mean anomaly of Venus:
$V = 212\overset{\circ}{.}603219 + 58320\overset{\circ}{.}0T + 197\overset{\circ}{.}803875T + 0\overset{\circ}{.}001286T^2$

Mean longitude of Venus:
$W = 342\overset{\circ}{.}767053 + 58320\overset{\circ}{.}0T + 199\overset{\circ}{.}211911T + 0\overset{\circ}{.}000310T^2$

Argument of latitude of Venus:
$R = 266\overset{\circ}{.}987406 + 58320\overset{\circ}{.}0T + 198\overset{\circ}{.}312061T - 0\overset{\circ}{.}000100T^2$

Mean anomaly of Mars:
$M = 319\overset{\circ}{.}529425 + 19080\overset{\circ}{.}0T + 59\overset{\circ}{.}858500T + 0\overset{\circ}{.}000181T^2$

Mean longitude of Mars:
$P = 293\overset{\circ}{.}747628 + 19080\overset{\circ}{.}0T + 61\overset{\circ}{.}699258T + 0\overset{\circ}{.}000311T^2$

Argument of latitude of Mars:
$X = 244\overset{\circ}{.}961186 + 19080\overset{\circ}{.}0T + 60\overset{\circ}{.}928267T + 0\overset{\circ}{.}000312T^2$

Mean anomaly of Jupiter:
$J = 225\overset{\circ}{.}444651 + 2880\overset{\circ}{.}0T + 154\overset{\circ}{.}906654T$

Mean longitude of Jupiter:
$Q = 237\overset{\circ}{.}352073 + 2880\overset{\circ}{.}0T + 154\overset{\circ}{.}906654T$

Argument of latitude of Jupiter:
$Y = 138\overset{\circ}{.}419251 + 2880\overset{\circ}{.}0T + 154\overset{\circ}{.}906654T$

Mean anomaly of Saturn:
$S = 175\overset{\circ}{.}758444 + 1080\overset{\circ}{.}0T + 142\overset{\circ}{.}116782T$

Mean anomaly of Uranus:
$U = 72\overset{\circ}{.}759796 + 360\overset{\circ}{.}0T + 68\overset{\circ}{.}513410T + 0\overset{\circ}{.}047410T^2$

To ensure full precision in evaluating the formulas in this table, terms consisting of a coefficient multiplied by T have often been separated into two parts. In the first part the coefficient is a multiple of 360°; in the second part the coefficient is less than 360°.

Stellar Tables

The Stellar Tables (Section F) list the mean and apparent places of 176 stars for the current year, along with coefficients for converting from mean to apparent place for any date in the year. The list of stars is essentially the same as that for the star tables on pages 268–273 of the *Nautical Almanac*. The stars are arranged in order of increasing right ascension (decreasing sidereal hour angle), except where both components of a binary system are listed, in which case the brighter component is listed first. For binary stars which can be resolved in small instruments, the position of one or both components is listed rather than the position of the center of gravity or the center of light. For convenience of navigators the sidereal hour angle (SHA) is tabulated rather than right ascension (RA); astronomers can obtain the right ascension in degrees from the relation $RA = 360° - SHA$.

The quantities tabulated for each star are, from left to right on the page:

(1) An identification number.

(2) The navigational star number, provided the star is one of the 57 selected navigation stars listed in the *Nautical Almanac* and *Air Almanac*.

(3) The star name. The Bayer designation is on the first line and the proper name, if any, is on the second line.

(4) The magnitude and spectral type. The visual magnitude is on the first line and the spectral type is on the second line. A composite spectrum is denoted by *.

(5) The mean place of the star for 1978.0. SHA in degrees is on the first line, and declination in degrees is on the second line.

(6) Four coefficients (H, R, S, C) in degrees for conversion from mean to apparent place. The coefficients on the first line are for the conversion of SHA; these will hereafter be designated H_S, R_S, S_S, C_S. The coefficients on the second line are for the conversion of declination; these will hereafter be designated H_D, R_D, S_D, C_D.

(7) The apparent place of the star for 1978.5. SHA in degrees is on the first line, and declination in degrees is on the second line.

The mean place of a star is to be regarded as a fundamental reference point with no simple geometric or observational significance. The apparent place of a star is the geocentric position, referred to the true equator and equinox of date, at which the star is observed. The apparent place is the position needed for navigational purposes, calibration of telescope setting circles, computation of transit times, *etc.* For work requiring accuracies of no better than $\pm 1\overset{'}{.}3$, the tabulated apparent place for 1978.5 can be used for any date during the year. To obtain apparent places to greater accuracy, the following procedures should be used:

For the desired date in 1978, determine τ, the fraction of the year elapsed. If the day of the year is t, τ can be computed from the quantities A and B listed at the beginning of the table: $\tau = t/A + B$.

Star positions accurate to better than $\pm 0\overset{'}{.}5$ can then be obtained by using the following formulas:

$$\text{apparent SHA} = \text{mean SHA} + H_S + R_S\tau$$
$$\text{apparent decl.} = \text{mean decl.} + H_D + R_D\tau$$

Star positions accurate to better than $\pm 0\overset{'}{.}1$ (and generally better than $\pm 0\overset{'}{.}05$) can be obtained by using the following formulas:

$$\text{apparent SHA} = \text{mean SHA} + H_S + R_S\tau + S_S \sin 360°\tau + C_S \cos 360°\tau$$
$$\text{apparent decl.} = \text{mean decl.} + H_D + R_D\tau + S_D \sin 360°\tau + C_D \cos 360°\tau$$

The tabulated apparent places for 1978.5 were computed using these latter formulas with $\tau = 0.500$.

Example: Compute the apparent place of Aldebaran (α Tauri) on 12 November 1978 to an accuracy of $0\overset{'}{.}1$.

From the calendar on page A4 or from the algorithm on page B1, 12 November is found to be day 316. From page F1, $A = 365.0000$ and $B = -0.0027$. Therefore $\tau = 316/365.000 - 0.0027 = 0.863$ and $360°\tau = 310\overset{\circ}{.}7$. Using the data for Aldebaran on page F2 (Aldebaran is star 26), we find:

Mean SHA	$291\overset{\circ}{.}3358$	Mean decl.	$+16\overset{\circ}{.}4661$
$+H_S$	$-\ 0.0012$	$+H_D$	$-\ 0.0022$
$+R_S\tau$	$-\ 0.0110$	$+R_D\tau$	$+\ 0.0014$
$+S_S \sin 360°\tau$	$-\ 0.0022$	$+S_D \sin 360°\tau$	$+\ 0.0007$
$+C_S \cos 360°\tau$	$-\ 0.0033$	$+C_D \cos 360°\tau$	$+\ 0.0003$
Apparent SHA	$291\overset{\circ}{.}3181$	Apparent decl.	$+16\overset{\circ}{.}4663$

Section B: APPLICATIONS

This section contains formulas and algorithms of general utility in astronomy and navigation.

Introduction

In this section reference will be made to the following functions:

Sign function. The sign function serves to extract the algebraic sign from a number. The notation sign(x) is defined to be sign(x) = 1 for $x \geqslant 0$, sign(x) = −1 for $x < 0$. An equivalent definition is sign(x) = $x/|x|$ for $x \neq 0$, sign(x) = 1 for $x = 0$.
Examples: sign(247) = 1, sign(−6.28) = −1.

Truncation or largest-integer function. The truncation function extracts the intetral part of a number. The algebraic sign of the result is the same as that of the original number. $\langle x \rangle$ is defined to be $\langle x \rangle = \text{sign}(x) \cdot N$, where N is the largest non-negative integer such that $N \leqslant |x|$.
Examples: $\langle 17.835 \rangle = 17$, $\langle -3.1416 \rangle = -3$.

Modulus or remainder function. The modulus function yields the remainder of the division x/y, when the quotient is constrained to be an integral value. Thus mod(x,y) is defined to be $\text{mod}(x,y) = x - \langle x/y \rangle \cdot y$.
Examples: mod(11,3) = 2, mod(−764.3,360.0) = −44.3.
Note that $\langle x \rangle = x - \text{mod}(x,1.0)$. Therefore the truncation function can be defined in terms of the modulus function and *vice versa*. If either modulus or truncation is available on a calculator or computer, the other function can be simply obtained.

In this almanac Universal Time (UT) is to be identified with UT1, which is equivalent to the standard navigational time argument Greenwich Mean Time (GMT). The symbols UT and GMT may therefore be considered interchangable. For detailed information on time systems the reader should consult the Explanation of a current edition of the *American Ephemeris and Nautical Almanac*.

Day of the Year

The day of the year, N, is defined as the integer $N = \langle t \rangle$, where t is the time elapsed in days since 0 January, 0^h UT, of the current year. Thus N takes on integer values between 1 and 365 (or 366 in leap years). The day of the year can be computed from either of the following formulas:

$$N = \left\langle \frac{275M}{9} \right\rangle - \left\langle \frac{M+9}{12} \right\rangle \cdot \left(1 + \left\langle \frac{K - 4\langle K/4 \rangle + 2}{3} \right\rangle\right) + I - 30$$

$$N = \left\langle \frac{275M}{9} \right\rangle - \left\langle \frac{M+9}{12} \right\rangle \cdot \left(1 + \left\langle \frac{\text{mod}(K,4) + 2}{3} \right\rangle\right) + I - 30$$

where N is the day of the year, K is the year (*e.g.*, 1978), M is the month $(1 \leqslant M \leqslant 12)$, and I is the day of the month $(1 \leqslant I \leqslant 31)$.

These formulas are equivalent and are valid for any year, except those century years that are not evenly divisible by 400. Therefore the formulas given

above are valid for the year 2000, but not for 1900 or 2100. In the above formulas the factor within the parentheses has the value 1 for leap years and 2 for non-leap years. Thus for a non-leap year, the following expression can be used:

$$N = \left\langle \frac{275M}{9} \right\rangle - 2\left\langle \frac{M+9}{12} \right\rangle + I - 30$$

For leap years the equivalent expression is

$$N = \left\langle \frac{275M}{9} \right\rangle - \left\langle \frac{M+9}{12} \right\rangle + I - 30$$

Many expressions in this almanac require the value of t, the time elapsed in days since 0 January, 0^h UT, of the current year. By inverting the definition of N, we obtain $t = N + \mathrm{UT}/24$, where UT is the Universal Time expressed in hours.

Julian Date

The Julian Date (JD) is a continuous count of days and fractions thereof from 1 January 4713 B.C. (=−4712 January 1), Greenwich Mean Noon (=12^h UT). For example A.D. 1978 January 1, 0^h UT, is JD 2443509.5 and A.D. 1978 July 21, 15^h UT, is JD 2443711.125. Conversion of Gregorian Calendar Date to Julian Date for the years A.D. 1801 through A.D. 2099 can be carried out with the following formula:

$$\mathrm{JD} = 367K - \left\langle \frac{7(K + \langle (M+9)/12 \rangle)}{4} \right\rangle + \left\langle \frac{275M}{9} \right\rangle + I + 1721013.5$$

$$+ \mathrm{UT}/24 - 0.5\,\mathrm{sign}(100K + M - 190002.5) + 0.5$$

where K is the year ($1801 \leqslant K \leqslant 2099$), M is the month ($1 \leqslant M \leqslant 12$), I is the day of the month ($1 \leqslant I \leqslant 31$), and UT is the Universal Time in hours. The last two terms in the formula add up to zero for all dates after 1900 February 28, so these two terms can be omitted for subsequent dates. Note that the formula makes use of the truncation and sign functions defined on page B1.

Example: Compute the JD corresponding to 1877 August 11, 7^h30^m UT.
Substituting $K = 1877$, $M = 8$, $I = 11$, and UT = 7.5 in the formula yields
$$\mathrm{JD} = 688859 - 3286 + 244 + 11 + 1721013.5 + 0.3125 + 0.5 + 0.5$$
$$= 2406842.8125$$

The Modified Julian Date (MJD) is sometimes used to specify current dates; it is defined as MJD = JD − 2400000.5. Use of the Modified Julian Date, rather than the Julian Date, is recommended with computers and calculators of limited precision. Note that for 0^h UT on any date the Julian Date has a fractional part of .5, while the corresponding Modified Julian Date is an integer.

If ephemeris time (ET) is used in the above formula instead of Universal Time (UT), the resulting quantity is designated Julian Ephemeris Date (JED).

Sidereal Time

The following formulas are relevant to the computation of sidereal time:

(1) $\mathrm{GMST} = 6^{\mathrm{h}}.62035556 + 0^{\mathrm{h}}.0657098232N + 1.0027379093\mathrm{UT}$

(2) $\mathrm{GMST} = 6^{\mathrm{h}}.67170278 + 0^{\mathrm{h}}.0657098232(\mathrm{JD0} - 2433282.5) + 1.0027379093\mathrm{UT}$

(3) $\Omega = 190^{\circ}.6067 - 0^{\circ}.0529539(N + \mathrm{UT}/24)$

(4) $\Omega = 372^{\circ}.1133 - 0^{\circ}.0529539(\mathrm{JD} - 2433282.5)$

(5) $E = -0^{\mathrm{h}}.00029 \sin\Omega$

(6) $\mathrm{GAST} = \mathrm{GMST} + E$

(7) $\mathrm{GAST} = \Sigma(t_0) + 1.0027379093\mathrm{UT} = \Sigma(t) + \mathrm{UT}$

(8) $\mathrm{LAST} = \mathrm{GAST} - \lambda/15$

where

GMST is the Greenwich mean sidereal time in hours;

Ω is the mean longitude of the ascending node of the Moon's orbit, measured in degrees;

E is the equation of the equinoxes in hours;

GAST is the Greenwich apparent sidereal time in hours;

LAST is the local apparent sidereal time in hours;

N is the day of the year ($1 \leqslant N \leqslant 365$ or, during a leap year, $1 \leqslant N \leqslant 366$);

UT is the Universal Time in hours;

JD0 and JD are the Julian Dates at 0^{h} UT of the day of interest and at the instant of interest, respectively;

$\Sigma(t_0)$ and $\Sigma(t)$ are values obtained by evaluating the Chebyshev series for Apparent Sidereal Time (pp. D1–D4 or E1) at 0^{h} UT of the day of interest and at the instant of interest, respectively;

λ is the local longitude in degrees (west is positive; east is negative).

When using the above formulas, it may be necessary to reduce the resulting hour values to the range $0^{\mathrm{h}}-24^{\mathrm{h}}$ by adding or subtracting multiples of 24^{h}.

Formulas (1) and (3) are specifically for the current year; the other formulas are valid at least over the latter half of this century. Formula (5) is an approximation that is accurate to about $\pm 0^{\mathrm{s}}.2$. If more accuracy is required, the Chebyshev series for the Equation of the Equinoxes (pp. D1–D4 or E1) can be used in place of Formula (5). If sidereal time is to be computed to an accuracy better than $\pm 0^{\mathrm{s}}.2$ (rarely justified for practical applications), then *either* the Chebyshev series for the Equation of the Equinoxes should be used in place of Formula (5) *or* Formula (7) should be used in place of Formula (6).

The above formulas can be easily adapted to allow the Modified Julian Date to be used in place of the Julian Date.

Hour Angles

The following formulas are useful if astronomical data, such as that given in Sections C and E, are applied to navigational purposes:

$$\mathrm{GHA} = 15(\mathrm{GAST} - \mathrm{RA})$$

$$\mathrm{LHA} = 15(\mathrm{LAST} - \mathrm{RA}) = \mathrm{GHA} - \lambda$$

$$\mathrm{GHA\ Aries} = 15\,\mathrm{GAST}$$

$$\mathrm{SHA} = 360^\circ - 15\,\mathrm{RA}$$

$$\mathrm{GHA} = \mathrm{GHA\ Aries} + \mathrm{SHA}$$

where

GHA is the Greenwich hour angle in degrees;
LHA is the local hour angle in degrees;
GHA Aries is the Greenwich hour angle of the First Point of Aries (the origin of right ascension) in degrees;
SHA is the sidereal hour angle in degrees;
RA is the apparent right ascension (referred to the true equator and equinox of date) in hours;
λ is the local longitude in degrees (west is positive; east is negative)
GAST is the Greenwich apparent sidereal time in hours;
LAST is the local apparent sidereal time in hours.

When using the above formulas, it may be necessary to add or subtract 360° to reduce the resulting hour angles to the range 0°–360°. Often local hour angle values are reduced to the range −180° to +180°, in which case they are called meridian angles. In all cases positive hour angle values are measured westward from the meridian.

Altitude and Azimuth

The following formulas can be used to compute the altitude (a) and azimuth (A) of a celestial body:

(1) $\sin a = \cos z = \sin\phi \sin\delta + \cos\phi \cos\delta \cos \mathrm{LHA}$

(2) $\tan x = (-\cos\delta \sin \mathrm{LHA}) / (\cos\phi \sin\delta - \sin\phi \cos\delta \cos \mathrm{LHA})$

$A = 360^\circ + x$ if in Eq. (2) the denominator is positive and the numerator is negative;
$A = x$ if both the denominator and numerator in Eq. (2) are positive;
$A = 180^\circ + x$ if the denominator of Eq. (2) is negative;

where

a is the altitude of the body above the horizon;

x is an auxiliary angle in the range $-90° \leqslant x \leqslant +90°$;

A is the azimuth of the body measured East from North over the range $0° \leqslant A \leqslant 360°$;

ϕ is the observer's latitude (north is positive; south is negative);

δ is the declination of the body;

LHA is the local hour angle of the body;

z is the zenith distance of the body ($z = 90° - a$).

If the computed value of $\sin a$ is negative, the body is below the horizon. The standard navigational notation for altitude is Hc, and the navigational notation for azimuth is Zn. Equations (1) and (2) are the basic expressions used in preparing Sight Reduction Tables.

Sunrise, Sunset and Twilight

The following algorithm provides a means of computing times of sunrise, sunset and twilight for the current year for specified locations. Between latitudes 65° North and 65° South the phenomena can be computed to an accuracy of $\pm 2^m$. Although the algorithm can be used at higher latitudes, its accuracy deteriorates near dates on which the Sun remains above or below the horizon for more than twenty-four hours.

Notation:
- ϕ = latitude of observer (north is positive; south is negative)
- λ = longitude of observer (west is positive; east is negative)
- M = Sun's mean anomaly
- L = Sun's true longitude
- α = Sun's right ascension
- δ = Sun's declination
- H = Sun's local hour angle
- z = Sun's zenith distance at rise, set or twilight*
- t = approximate time of phenomenon in days since 0 Jan., 0^hUT
- T = local mean time of phenomenon
- UT = Universal Time of phenomenon

*The proper value of z should be chosen from the following:

	z	$\cos z$
Sunrise and Sunset	90°50′	−0.01454
Civil Twilight	96°	−0.10453
Nautical Twilight	102°	−0.20791
Astronomical Twilight	108°	−0.30902

Formulas for 1978:

(1) $M = 0\overset{\circ}{.}985600t - 3\overset{\circ}{.}251$

(2) $L = M + 1\overset{\circ}{.}916 \sin M + 0\overset{\circ}{.}020 \sin 2M + 282\overset{\circ}{.}565$

(3) $\tan \alpha = 0.91746 \tan L$

(4) $\sin \delta = 0.39782 \sin L$

(5) $\cos H = (\cos z - \sin \delta \sin \phi)/(\cos \delta \cos \phi)$

(6) $T = H + \alpha - 0\overset{h}{.}065710t - 6\overset{h}{.}620$

(7) $UT = T + \lambda$

Procedure:

1. With an initial value of t, compute M from Eq. (1) and then L from Eq. (2). If a morning phenomenon (sunrise or the beginning of morning twilight) is being computed, construct an initial value of t from the formula
$$t = N + (6^h + \lambda)/24$$
where N is the day of the year (see the calendar on pages A2–A4 or the formulas on page B1) and λ is the observer's longitude expressed in hours. If an evening phenomenon is being computed, use
$$t = N + (18^h + \lambda)/24$$
2. Solve Eq. (3) for α, noting that α is in the same quadrant as L. Transform α to hours for later use in Eq. (6).
3. Solve Eq. (4) for $\sin \delta$ which appears in Eq. (5); $\cos \delta$, which also is required in Eq. (5), should be determined from $\sin \delta$. While $\sin \delta$ may be positive or negative, $\cos \delta$ is always positive.
4. Solve Eq. (5) for H. Since computers and calculators normally give the arccosine in the range 0°–180°, the correct quadrant for H can be selected according to the following rules:
(a) rising phenomena, $H = 360° - \arccos H$;
(b) setting phenomena, $H = \arccos H$.
In other words, for rising phenomena H must be either in quadrant 3 or 4 (depending on the sign of $\cos H$), whereas H must be either in quadrant 1 or 2 for setting phenomena. Convert H from degrees to hours for use in Eq. (6).
5. Compute T from Eq. (6), recalling that H and α must be expressed in hours. If T is negative or greater than 24^h, it should be converted to the range 0^h–24^h by adding or subtracting multiples of 24^h.
6. Compute UT from Eq. (7), where λ must be expressed in hours. UT is an approximation to the time of sunrise, sunset or twilight, referred to the Greenwich meridian. If UT is greater than 24^h, the phenomenon occurs on the following day, Greenwich time. If UT is negative, the phenomenon occurs on the previous day, Greenwich time.

To ensure that precision is not lost during the computations, t should be carried to four decimal places. Angles should be expressed to three decimals of a degree and, upon conversion, to three decimals of an hour. Five significant digits should be carried for the trigonometric functions.

Under certain conditions Eq. (5) will yield a value of $|\cos H| > 1$. This mathematical embarrassment indicates the absence of the phenomenon on that day. At far northern latitudes, for example, there is continuous illumination during certain summer days and continuous darkness during winter days.

Example: Compute the time of sunset on 4 July at Washington, D.C.

Latitude = 38°54′ North Longitude = 77°04′ West

$\lambda = +77^\circ\!.067/15 = +5^h\!.138$

$\phi = +38^\circ\!.9$ $\sin\phi = 0.62796$ $\cos\phi = 0.77824$

For sunset: $z = 90°50'$ $\cos z = -0.01454$

$t = 185^d + (18^h + 5^h\!.138)/24 = 185^d\!.9641$

$M = 0^\circ\!.985600(185.9641) - 3^\circ\!.251 = 180^\circ\!.035$

$L = 180^\circ\!.035 + 1^\circ\!.916(-0.00061) + 0^\circ\!.020(0.00122) + 282^\circ\!.565$
$= 462^\circ\!.599 = 102^\circ\!.599$

$\tan\alpha = 0.91746(-4.47411) = -4.10482$

$\alpha = 103^\circ\!.691 = 6^h\!.913$ Since L is in quadrant 2, so is α.

$\sin\delta = 0.39782(0.97592) = 0.38824$

$\cos\delta = 0.92156$

$\cos H = [-0.01454 - (0.38824)(0.62796)]/[(0.92156)(0.77824)]$
$= -0.36021$

Since sunset is being computed and $\cos H$ is negative, H is in the second quadrant: $H = 111^\circ\!.113 = 7^h\!.408$

$T = 7^h\!.408 + 6^h\!.913 - 0^h\!.065710(185.9641) - 6^h\!.620 = -4^h\!.519$
$= 19^h\!.481$

$UT = 19^h\!.481 + 5^h\!.138 = 24^h\!.619$

Sunset occurred at $0^h 37^m$ UT on 5 July = $20^h 37^m$ EDT on 4 July.

Example: Compute the beginning of nautical twilight on 12 January at latitude 62°.5 South, longitude 7°.0 East.

$\lambda = -7^\circ\!.0/15 = -0^h\!.467$

$\phi = -62^\circ\!.5$ $\sin\phi = -0.88701$ $\cos\phi = 0.46175$

For nautical twilight: $z = 102°$ $\cos z = -0.20791$

$t = 12^d + (6^h - 0^h\!.467)/24 = 12^d\!.2305$

$M = 0^\circ\!.985600(12.2305) - 3^\circ\!.251 = 8^\circ\!.803$

$L = 8^\circ\!.803 + 1^\circ\!.916(0.15304) + 0^\circ\!.020(0.30247) + 282^\circ\!.565$
$= 291^\circ\!.667$

$\tan\alpha = 0.91746(-2.51711) = -2.30935$

$\alpha = 293^\circ\!.414 = 19^h\!.561$ Since L is in quadrant 4, so is α.

$\sin\delta = 0.39782(-0.92935) = -0.36971$

$\cos\delta = 0.92915$

$\cos H = [-0.20791 - (-0.36971)(-0.88701)]/[(0.92915)(0.46175)]$
$= -1.24896$

Since the computed absolute value of $\cos H$ is greater than 1, there is no beginning time for morning nautical twilight on this date.

Moonrise and Moonset

Times of moonrise and moonset can be computed for specified locations using the following algorithm. Between latitudes 60° North and 60° South, the phenomena can be computed to an accuracy of $\pm 5^m$. Although the algorithm can be used at higher latitudes, its accuracy deteriorates near dates on which the Moon remains above or below the horizon for more than twenty-four hours.

Notation:
ϕ = latitude of observer (north is positive; south is negative)
λ = longitude of observer (west is positive; east is negative)
t_i = *i-th* approximation to Universal Time of phenomenon, expressed in days from 0 January, 0^h UT
GHA_i = Moon's GHA at time t_i
δ_i = Moon's declination at time t_i
τ_i = *i-th* correction to t_0, thus $t_i = t_0 + \tau_i$
H_i = *i-th* approximation to Moon's LHA at time of rise or set
ΔH_i = *i-th* approximation to Moon's daily rate of change in GHA

Formulas:

(1) $\Delta H_i = (GHA_i - GHA_0)/\tau_i$ for $i = 0$, let $\Delta H_0 = 347^\circ\!.81$
(2) $\cos H_{i+1} = (0^\circ\!.00233 - \sin\phi \sin\delta_i)/(\cos\phi \cos\delta_i)$
(3) $\tau_{i+1} = (H_{i+1} - H_0)/\Delta H_i$
(4) $t_{i+1} = t_0 + \tau_{i+1}$

Procedure:

1. Let $t_0 = N + (12^h + \lambda)/24$, where N is the day of the year (see the calendar on pages A2–A4 or the formulas on page B1) and λ is the observer's longitude expressed in hours. Set $i = 0$ and begin the following iterative process.
2. For time t_i compute the Moon's GHA and declination to navigational precision ($\pm 0'\!.1$). Label these quantities GHA_i and δ_i, respectively, where i specifies the iteration number. For $i = 0$, compute $H_0 = GHA_0 - \lambda$.
3. If $i = 0$, let $\Delta H_0 = 347^\circ\!.81$. Otherwise compute ΔH_i from Eq. (1). If $\Delta H_i < 0$, add $360^\circ/|\tau_i|$ to ΔH_i.
4. Solve Eq. (2) for H_{i+1}. Since computers and calculators normally give the arccosine in the range 0°–180°, the correct quadrant for H_{i+1} can be selected according to the following rules:
   (a) moonrise computations, $H_{i+1} = 360^\circ - \arccos H_{i+1}$;
   (b) moonset computations, $H_{i+1} = \arccos H_{i+1}$.
   In other words, near the time of moonrise H_{i+1} must be either in quadrant 3 or 4 (depending on the sign of $\cos H_{i+1}$); near moonset H_{i+1} must be either in quadrant 1 or 2. For latitudes higher than 60° (*i.e.*, $|\phi| > 60^\circ$), the condition $|\cos H_{i+1}| > 1$ can occur, thereby indicating the absence of the phenomenon on that day.

5. Compute τ_{i+1} from Eq. (3). If $|\tau_{i+1}| < 0^d.5$, proceed to Step 6. If $|\tau_{i+1}| > 0^d.5$, the phenomenon being computed occurs on the day prior to the day desired (if τ_{i+1} is negative) or on the day following the day desired (if τ_{i+1} is positive). Normally the phenomenon on the desired day can be obtained by adding to τ_{i+1} (if τ_{i+1} is negative), or subtracting from τ_{i+1} (if τ_{i+1} is positive), $360°/\Delta H_i$. If successful this technique will produce a new value of τ_{i+1} in the required range. However, two conditions may prevent the reduction to $|\tau_{i+1}| < 0^d.5$:
   (a) for low values of i, τ_{i+1} may be a fairly crude approximation to the ultimate value, τ_n;
   (b) each month there is one day (near last quarter) on which there is no moonrise, and another day (near first quarter) on which there is no moonset.

   If $|\tau_{i+1}| \approx 0^d.5$, it is probably worth attempting another iteration to see if $|\tau_{i+2}| < 0^d.5$.
6. Compute t_{i+1} from Eq. (4). If $|t_{i+1} - t_i| < 0^d.01$, t_{i+1} is accurate to $\pm 5^m$. Otherwise it is necessary to iterate the solution by setting $i = i + 1$ and executing Steps 2 through 6 again.

Example: Compute the time of moonset on 16 March 1978 at latitude 38°54′ South and longitude 77°04′ West.

$\lambda = +77°.067 = +5^h.138$

$\phi = -38°.9$ $\quad\quad$ $\sin\phi = -0.62796$ $\quad\quad$ $\cos\phi = 0.77824$

From the calendar on pages A2–A4 or the formulas on page B1, 16 March is found to be day 75, so $t_0 = 75^d + (12^h + 5^h.138)/24 = 75^d.71408$.

$i = 0$:

$GHA_0 = 346°.028$ $\quad\quad$ $\delta_0 = +18°.170$

$H_0 = 346°.028 - 77°.067 = 268°.961$

$\Delta H_0 = 347°.81$

$\cos H_1 = [0.00233 - (-0.62796)(0.31184)]/[(0.77824)(0.95014)]$
$= +0.26798$

Since moonset is sought, H_1 is in quadrant 1 or 2: $H_1 = 74°.456$

$\tau_1 = (74°.456 - 268°.961)/347°.81 = -0^d.55923$

Since $|\tau_1| > 0^d.5$, we try

$\tau_1 = -0^d.55923 + 360°/347°.81 = +0^d.47582$, which is satisfactory.

$t_1 = 75^d.71408 + 0^d.47582 = 76^d.1899 = 17$ March $04^h 33^m$UT
$= 16$ March $23^h 33^m$, 75^{th} Meridian West

$i = 1$:

$GHA_1 = 151°.862$ $\quad\quad$ $\delta_1 = +18°.179$

$\Delta H_1 = (151°.862 - 346°.028)/0.47582 = -408°.066$

Since a negative value of ΔH_1 cannot be used, we set

$\Delta H_1 = -408°.066 + 360°/0.47582 = +348°.523$

$\cos H_2 = [0.00233 - (-0.62796)(0.31199)]/[(0.77824)(0.95009)]$
$= +0.26812$

Since moonset is sought, H_2 is in quadrant 1 or 2: $H_2 = 74°.448$

$\tau_2 = (74^\circ.448 - 268^\circ.961)/348^\circ.523 = -0^d.55811$
Again we seek $|\tau_2| < 0^d.5$, so
$\tau_2 = -0^d.55811 + 360^\circ/348^\circ.523 = +0^d.47482$
$t_2 = 75^d.71408 + 0^d.47482 = 76^d.1889 = $ 17 March $04^h 32^m$ UT
$=$ 16 March $23^h 32^m$, 75^{th} Meridian West
Since $|t_2 - t_1| = 0^d.001 < 0^d.01$, t_2 is accurate to $\pm 5^m$.

The extremely rapid convergence illustrated in this example occurs frequently but not invariably. Although the first approximation (t_1) will often give adequate precision for most purposes, it is recommended that the solution be iterated and that the convergence criterion ($|t_{i+1} - t_i| < 0^d.01$) be tested.

Equation of Time

The equation of time, the hour angle of the apparent (true) Sun minus the hour angle of the mean (fictitious) Sun, can be represented to reasonable precision by the following formula:

$$\begin{aligned} \text{EqT} = & -97^s.8 \sin l - 431^s.3 \cos l + 596^s.6 \sin 2l - 1^s.9 \cos 2l \\ & + 4^s.0 \sin 3l + 19^s.3 \cos 3l - 12^s.7 \sin 4l \end{aligned}$$

where EqT is the equation of time in seconds and l is the Sun's mean longitude.

$l = 279^\circ.697 + 0^\circ.98564734(\text{JD} - 2415020.0) = 279^\circ.311 + 0^\circ.98564734t$

In the equation for l, JD is the Julian Date and t is the elapsed time in days and fractions thereof since 0 January 1978, 0^h UT. Formulas for computing JD and t are given on pages B1–B2. Values of l and its multiples may have to be reduced to the range $0^\circ - 360^\circ$ by adding or subtracting multiples of 360°.

The local mean time of solar transit is given by 12^h minus EqT. Thus EqT represents the difference local apparent (sundial) time minus local mean time.

Polaris (Pole Star)

The following formulas are relevant to observations of Polaris:

(1) $\phi = a - p \cos h + 0.5 p \sin p \sin^2 h \tan \phi$

(2) $A \cos \phi = p \sin h + p \sin p \sin h \cos h \tan \phi$

where p is the polar distance of Polaris: $p = 90^\circ$ − declination of Polaris
h is the LHA of Polaris: h = GHA Aries + SHA Polaris + east (−west) longitude of observer
ϕ is the observer's latitude;
A is the azimuth of Polaris;
a is the corrected altitude of Polaris.

Eq. (1) permits the observer's latitude to be determined from an observation of the altitude of Polaris (corrected for refraction, dip, *etc*.). Assumed values of the observer's latitude and longitude can be used for the right side of Eq. (1).

Eq. (2) yields the azimuth of Polaris if the observer's position is known. These expressions are accurate only for Polaris, since they depend on p being a small quantity. The SHA and declination of Polaris to be used in these formulas should be referred to the true equator and equinox of date; *i.e.*, the apparent place of Polaris should be computed (see Section F 'Stellar Tables'; Polaris is star number 17).

Equation of Position Line

The following formula can be used to obtain a line of position (LOP) directly from an observation of the altitude of a celestial body:

$$\lambda = \mathrm{GHA} \pm \arccos[(\sin a - \sin\phi \sin d)/\cos\phi \cos d]$$

where: λ is the computed longitude;
GHA is the GHA of the body for the time of observation;
a is the corrected altitude of the body;
d is the declination of the body for the time of observation;
ϕ is an estimate of the observer's latitude.

North latitudes and west longitudes are positive; south latitudes and east longitudes are negative. Longitudes with absolute values greater than 180° may be encountered. The operation connecting the two terms is + for bodies east of the meridian (rising) and − for bodies west of the meridian (setting).

The formula yields the longitude λ at which the position line crosses the parallel of latitude ϕ. Repeated application of the formula using different latitude values yields a locus of points all lying on the LOP. Note that no assumed position is necessary, although an estimate of the observer's latitude is helpful in reducing the number of times the formula is applied.

The formula becomes indeterminate at the transit time of a body and for latitudes which the position line does not cross at any point.

Motion of Body and Motion of Observer

The following formula gives the change of altitude of a celestial body, due to the rotation of the Earth, in the time interval Δt (*e.g.*, the interval between a sextant observation and the time of a fix). This correction may be applied to the observed altitude to permit the use of a common assumed position and LHA Aries for observations made at different times.

$$MOB = 15.04\, \Delta t \cos\phi \sin A$$

where MOB is the altitude correction in minutes of arc, Δt is the time difference in minutes, ϕ is the latitude of the observer, and A is the azimuth of the observed body. If the time of the fix is later than the time of observation, MOB should be added to the observed altitude.

The following formula gives the change of altitude of a celestial body, due to

the motion of the observer, in the time interval Δt (*e.g.*, the interval between a sextant observation and the time of a fix). This correction may be applied to the altitude in lieu of advancing or retiring a line of position.

$$MOO = \frac{v\,\Delta t}{60}\cos(A - C)$$

where MOO is the altitude correction in minutes of arc, Δt is the time difference in minutes, A is the azimuth of the observed body, C is the track/course angle, and v is the ground speed in knots. If the time of the fix is later than the time of observation, MOO should be added to the observed altitude.

Sextant Altitude Corrections

Several corrections must be applied to a sextant altitude (hs) in order to obtain a corrected altitude (Ho). Ho can then be either (a) compared with the computed altitude (Hc) to obtain the altitude difference (Δa); or (b) used in the 'Equation of Position Line' (see page B11) in order to obtain directly the location of the LOP for the sight.

The corrections, in the order in which they should be applied, are:

(1) Instrument and/or index correction, IC;
(2a) Dip of horizon, D (marine sextant);
or
(2b) Coriolis correction, Δz (bubble sextant);
(3) Atmospheric refraction, R;
(4) Semi-diameter, SD (marine sextant, Sun and Moon observations);
(5) Parallax in altitude, PA (Moon, Venus and Mars observations).

In mathematical notation:

$$\text{Ho} = \text{hs} + \text{IC} + (\text{D or } \Delta z) - \text{R} + \text{SD} + \text{PA}$$

If Venus is observed, an additional correction for the phase of the planet may be necessary. This correction can be made either to the sextant altitude or to the GHA or LHA of Venus.

Descriptions and formulas for D, Δz, R, SD, PA and the phase correction for Venus are given in the following pages.

Dip of Horizon

The dip of the apparent horizon from a horizontal plane is given by

$$\text{D} = -0.97\sqrt{h}$$

where h is the height of eye level of the observer in feet and D is the dip of the horizon in minutes of arc. For observations of a celestial body made with a marine sextant or similar instrument, D should be added to the observed altitude to obtain the corrected altitude. This formula is an approximation; the apparent dip varies with atmospheric conditions.

Coriolis Correction

Any object moving across or above the surface of the rotating Earth is subject to an apparent force tending to push the object to the right in the northern hemisphere and to the left in the southern hemisphere. This Coriolis acceleration manifests itself as a deflection of the apparent vertical by an amount Z:

(1) $$Z = 2.62\,V\sin\phi + 0.146\,V^2\sin C\tan\phi - 5.25\,VC'$$

where: Z is the deflection in minutes of arc;
V is the speed in hundreds of knots;
ϕ is the latitude;
C is the true track/course angle;
C' is the rate of change of true track/course angle in degrees per minute of time.

Usually only the first term on the right of Eq. (1) is significant.

Observations of the altitudes of celestial bodies made with bubble sextants or similar artificial horizon instruments must be corrected for the Coriolis effect. The correction Δz, which can be added to the observed (*e.g.*, bubble sextant) altitude, is given approximately by

(2) $$\Delta z = Z\sin(A - C)$$

where: Δz is the altitude correction in minutes of arc;
Z is the deflection of the vertical determined from Eq. (1);
A is the azimuth of observed body;
C is the true track/course angle.

In the northern hemisphere the correction Δz is positive for stars on the right and negative for stars on the left of the aircraft. In the southern hemisphere the correction is negative for stars on the right and positive for stars on the left.

Atmospheric Refraction

The Earth's atmosphere tends to refract light in such a way that celestial bodies appear slightly higher in the sky than they would if there were no atmosphere. The formulas below can be used to determine R, the angle of refraction. R should be subtracted from an observed (*e.g.*, sextant) altitude to obtain the corrected altitude.

(1) $$R = \frac{P}{273 + T}[3.430289(z - \arcsin[0.9986047\sin(0.9967614z)]) - 0.01115929z]$$

(2) $$R = \exp(-h/27000)\tan z = 1/[\exp(h/27000)\tan a]$$

where: R is the refraction correction in minutes of arc;
a is the observed altitude
z is the observed zenith distance in degrees: $z = 90° - a$

T is the temperature in degrees Celsius;
P is the atmospheric pressure in millibars;
h is the height of the observer above sea level in feet.

Eq. (1) is more suitable for surface observations, while Eq. (2) is more suitable for observations from aircraft. Both formulas are approximations and are not equivalent to a complete theory of refraction. Eq. (2), which should be used only for altitudes greater than 10°, is accurate to about 0.′2. Eq. (1) can be used for all altitudes: for altitudes greater than 15°, it is accurate to 0.′1 or better; for altitudes between 3° and 15°, errors between 0.′1 and 1.′0 may arise; for altitudes less than 3°, errors between 1′ and 3′ may be expected.

Semi-diameter of the Sun and Planets

When not available directly from almanac data, the semi-diameters of the Sun and planets can be computed from

$$SD = S/d = S\pi/8.794$$

where: SD is the semi-diameter in seconds of arc;
S is the semi-diameter at unit distance (1 AU) in seconds of arc;
d is the geocentric distance in AU;
π is the horizontal parallax in seconds of arc.

The following values of S should be used:

Sun	959.″63	Jupiter	98.″47
Mercury	3.34	Saturn	83.33
Venus	8.41	Uranus	34.28
Mars	4.68	Neptune	36.56

These values apply to the equatorial dimensions of the bodies and do not include any adjustments for irradiation.

Semi-diameter of the Moon

When not available directly from almanac data, the semi-diameter of the Moon can be computed from

(1) $$SD = 56204.92/d = 0.272476\pi$$

where SD is the semi-diameter in seconds of arc, d is the geocentric distance of the Moon in units of the Earth's equatorial radius, and π is the horizontal parallax of the Moon in seconds of arc.

Computed this way, the semi-diameter applies to a fictitious observer located at the center of the Earth. The observed semi-diameter of the Moon will be slightly greater than the geocentric semi-diameter, since a real observer located on the surface of the Earth will be slightly closer to the Moon (assuming it is above the horizon). For navigational and certain other purposes the *augmented semi-diameter* of the Moon should be used:

$$\text{(2)} \qquad SD_{aug} = SD[1 + (\sin a)/d]$$

where SD_{aug} is the augmented semi-diameter in seconds of arc, a is the altitude of the Moon (for navigational purposes a = Ho, but hs or Hc can be used instead with negligible error), d is the geocentric distance of the Moon in units of the Earth's equatorial radius, and SD is the geocentric semi-diameter computed from Eq. (1). For navigational purposes a constant value of $d = 60.27$ can be used to sufficient accuracy. The increase in the Moon's semi-diameter due to augmentation is zero when the Moon is on the horizon and is about 0$'$.3 when the Moon is at the zenith.

Parallax in Altitude

The finite size of the Earth causes a parallactic shift in the apparent positions of nearby celestial objects. The resulting parallax in altitude can be computed from

$$\sin PA = \sin \pi \cos a$$

where PA is the parallax in altitude, π is the horizontal parallax, and a is the observed altitude. When the horizontal parallax of a body is not available, it may be computed from the relation $\pi = 8''.794/d$, where d is the geocentric distance of the body in astronomical units. The parallax in altitude can exceed $1'$ only for the Moon. Since parallax tends to decrease the apparent altitude of a body, the quantity PA should be added to an observed (*e.g.*, sextant) altitude in order to obtain the corrected altitude. To a reasonable approximation, PA can also be computed from

$$PA = \pi \cos a$$

Correction for the Phase of Venus

When the altitude of Venus is observed with a small instrument, a correction to the observed altitude is required to account for the fact that the center of light, rather than the center of the disk, is observed. This correction has the form $-k \cos\theta$, where k is a correction factor (given below) and θ is the angle on the celestial sphere, at the position of Venus, between the observer's vertical and the direction of the Sun. The correction, which should be added to the observed (*e.g.*, sextant) altitude, is positive when the Sun is lower than Venus, zero when they have the same altitude, and negative when the Sun is higher.

In sight reduction this effect can be approximately taken into account by correcting the GHA (or LHA) of Venus rather than correcting the observed altitude. Simply add k to the GHA (or LHA) of Venus when Venus is east of the Sun (*i.e.*, when Venus is an evening planet), and subtract k from the GHA (or LHA) when Venus is west of the Sun (morning planet). The correction should not be applied in this way near the time of superior or inferior conjunction.

Venus is at superior conjunction on 22 January 1978 and at inferior conjunction on 7 November 1978. Between these two dates Venus is in the evening sky. Before 22 January and after 7 November Venus is in the morning sky.

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The values of k for 1978 are:

		k
Jan.	1	
July	23	0.0
Sept.	10	0.1
Oct.	3	0.2
Oct.	19	0.3
Nov.	30	0.4
Dec.	15	0.3
Dec.	31	0.2

Section C: NAVIGATIONAL TABLES

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 1 THRU 32 JD 2443509.5 TO 2443541.5 DATES JAN 1 THRU FEB 1

A = 16.00000000 B = -1.06250000

POWERS OF TIME COEFFICIENTS

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
	0	0	0	0
0	6236.0627	6297.5195	-20.8507	0.2717
1	5775.7708	5758.6564	3.0968	0.0
2	-0.0036	0.3829	0.8462	0.0
3	-0.0029	0.0441	-0.0642	0.0
4	0.0031	-0.0206	-0.0058	0.0
5	0.0027	0.0013	0.0044	0.0

	VENUS GHA	VENUS DEC	MARS GHA	MARS DEC	JUPITER GHA	JUPITER DEC	SATURN GHA	SATURN DEC
	0	0	0	0	0	0	0	0
0	6298.6757	-21.9415	6469.0319	23.5672	6148.2945	23.2308	6444.0467	13.0731
1	5754.3506	3.1818	5782.3633	1.7888	5777.5882	0.0174	5776.6874	0.3893
2	0.5050	1.4160	0.5520	-0.2339	-0.3261	-0.0067	0.1582	0.0494
3	0.1106	-0.0903	-0.5464	-0.1630	-0.0474	0.0025	-0.0159	-0.0113
4	-0.0287	-0.0192	-0.0352	0.0211	0.0066	0.0017	-0.0022	0.0002
5	-0.0003	0.0001	0.0211	0.0073	-0.0020	0.0009	-0.0038	0.0014

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 32 THRU 63 JD 2443540.5 TO 2443572.5 DATES FEB 1 THRU MAR 4

A = 16.00000000 B = -3.00000000

POWERS OF TIME COEFFICIENTS

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
	0	0	0	0
0	5906.6176	5936.4739	-12.1805	0.2699
1	5775.7704	5760.2680	5.5699	0.0007
2	-0.0027	0.3863	0.4151	0.0004
3	-0.0005	-0.0411	-0.0755	-0.0031
4	0.0019	-0.0124	-0.0007	0.0006
5	0.0003	0.0028	-0.0017	0.0015

	VENUS GHA	VENUS DEC	MARS GHA	MARS DEC	JUPITER GHA	JUPITER DEC	SATURN GHA	SATURN DEC
	0	0	0	0	0	0	0	0
0	5930.0280	-11.3297	6150.5664	25.4444	5820.8753	23.2701	6116.7975	13.9407
1	5756.7377	7.2618	5778.8838	0.0538	5775.9499	0.0342	5777.0151	0.4675
2	0.5409	0.6408	-1.8261	-0.4126	-0.4674	0.0107	0.0016	-0.0099
3	-0.0823	-0.1442	-0.0564	0.0605	0.0046	0.0001	-0.0258	-0.0102
4	-0.0191	0.0020	0.0888	0.0034	0.0053	-0.0003	-0.0007	-0.0012
5	0.0028	-0.0020	-0.0185	-0.0043	-0.0032	0.0006	-0.0041	-0.0009

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 60 THRU 91 JD 2443568.5 TO 2443600.5 DATES MAR 1 THRU APR 1

A = 16.00000000 B = -4.75000000

POWERS OF TIME COEFFICIENTS

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
	0	0	0	0
0	5934.2152	5937.8493	-1.5738	0.2681
1	5775.7702	5761.1494	6.3239	0.0
2	0.0006	0.1165	0.0217	0.0041
3	0.0009	-0.0638	-0.0760	-0.0022
4	-0.0008	-0.0044	0.0020	-0.0039
5	-0.0009	0.0046	0.0045	0.0004

	VENUS GHA	VENUS DEC	MARS GHA	MARS DEC	JUPITER GHA	JUPITER DEC	SATURN GHA	SATURN DEC
	0	0	0	0	0	0	0	0
0	5925.4155	2.5712	5818.2529	24.5618	5847.3993	23.3605	6146.4187	14.6688
1	5757.6440	8.1900	5773.0678	-0.9464	5774.3992	0.0611	5776.7515	0.3373
2	-0.0430	-0.1058	-1.3243	-0.2088	-0.4013	-0.0013	-0.1455	-0.0591
3	-0.1210	-0.1381	0.1755	0.0103	0.0312	0.0008	-0.0212	-0.0093
4	-0.0017	0.0014	0.0017	-0.0097	0.0029	0.0003	0.0036	0.0013
5	0.0030	-0.0022	-0.0155	0.0013	-0.0081	-0.0040	-0.0003	0.0030

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 91 THRU 122 JD 2443599.5 TO 2443631.5 DATES APR 1 THRU MAY 2

A = 16.00000000 B = -6.68750000

POWERS OF TIME COEFFICIENTS

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
	0	0	0	0
0	5964.7700	5940.0687	10.2699	0.2665
1	5775.7718	5760.9434	5.6549	-0.0019
2	0.0007	-0.1937	-0.3632	-0.0026
3	-0.0033	-0.0455	-0.0628	0.0016
4	-0.0006	0.0013	0.0017	0.0020
5	0.0018	0.0017	-0.0003	-0.0005

	VENUS GHA	VENUS DEC	MARS GHA	MARS DEC	JUPITER GHA	JUPITER DEC	SATURN GHA	SATURN DEC
	0	0	0	0	0	0	0	0
0	5919.8714	17.0287	5839.6762	21.9457	5873.9660	23.4500	5818.2079	15.0666
1	5756.2899	6.2030	5769.5084	-1.7652	5773.1079	0.0150	5776.0134	0.0600
2	-0.5588	-0.9228	-0.5843	-0.2226	-0.2637	-0.0280	-0.2217	-0.0782
3	-0.0297	-0.1332	0.1036	-0.0009	0.0232	-0.0048	-0.0029	0.0042
4	0.0199	0.0030	-0.0117	0.0023	-0.0042	0.0028	0.0038	0.0012
5	0.0024	-0.0024	-0.0066	-0.0013	-0.0007	-0.0001	-0.0008	-0.0029

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 121 THRU 152 JD 2443629.5 TO 2443661.5 DATES MAY 1 THRU JUNE 1

A = 16.00000000 B = -8.56250000

POWERS OF TIME COEFFICIENTS

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
	0	0	0	0
0	5994.3389	5940.9262	19.1941	0.2642
1	5775.7707	5759.9108	3.6563	-0.0033
2	0.0036	-0.2952	-0.6943	0.0
3	-0.0026	0.0095	-0.0530	0.0061
4	-0.0031	0.0076	0.0038	0.0
5	0.0025	0.0009	0.0015	-0.0037

	VENUS GHA	VENUS DEC	MARS GHA	MARS DEC	JUPITER GHA	JUPITER DEC	SATURN GHA	SATURN DEC
	0	0	0	0	0	0	0	0
0	5911.0781	24.5849	5855.9431	17.8494	5897.7485	23.3624	5847.4571	14.9130
1	5754.5962	1.4828	5768.0480	-2.6059	5772.3344	-0.1199	5775.1942	-0.2214
2	-0.1392	-1.5019	-0.2369	-0.2202	-0.1501	-0.0412	-0.2073	-0.0698
3	0.1751	-0.0375	0.0494	0.0030	0.0182	-0.0017	0.0057	0.0039
4	0.0137	0.0228	-0.0077	-0.0007	0.0005	-0.0032	0.0009	-0.0006
5	-0.0089	0.0002	-0.0060	0.0012	-0.0005	-0.0001	0.0012	-0.0016

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 152 THRU 183 JD 2443660.5 TO 2443692.5 DATES JUNE 1 THRU JULY 2

A = 16.00000000 B = -10.50000000

POWERS OF TIME COEFFICIENTS

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
	0	0	0	0
0	6024.8941	5939.8385	23.3613	0.2633
1	5775.7686	5759.1417	0.5232	0.0
2	0.0001	-0.0375	-0.8772	0.0
3	0.0043	0.0599	-0.0043	0.0
4	-0.0001	-0.0018	0.0048	0.0
5	-0.0027	0.0010	-0.0016	0.0

	VENUS GHA	VENUS DEC	MARS GHA	MARS DEC	JUPITER GHA	JUPITER DEC	SATURN GHA	SATURN DEC
	0	0	0	0	0	0	0	0
0	5901.3565	21.8592	5870.8590	12.0138	5921.2143	22.9532	5876.1813	14.2395
1	5755.9633	-4.1147	5767.4274	-3.3890	5771.9551	-0.3058	5774.4952	-0.4649
2	0.7499	-1.2289	-0.1035	-0.1793	-0.0493	-0.0516	-0.1500	-0.0550
3	0.0808	0.1155	0.0104	0.0094	0.0136	-0.0060	0.0094	0.0045
4	-0.0284	0.0096	-0.0079	0.0022	-0.0007	0.0009	-0.0001	0.0013
5	-0.0040	-0.0024	0.0	0.0	0.0007	0.0040	0.0004	-0.0002

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 182 THRU 213 JD 2443690.5 TO 2443722.5 DATES JULY 1 THRU AUG 1

A = 16.00000000 B = -12.37500000

POWERS OF TIME COEFFICIENTS

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
	0	0	0	0
0	6054.4635	5938.4967	21.2958	0.2633
1	5775.7702	5759.6428	-2.6588	0.0
2	0.0007	0.2825	-0.7734	0.0
3	0.0011	0.0211	0.0412	0.0
4	-0.0008	-0.0119	0.0066	0.0
5	-0.0011	0.0057	0.0007	0.0

	VENUS GHA	VENUS DEC	MARS GHA	MARS DEC	JUPITER GHA	JUPITER DEC	SATURN GHA	SATURN DEC
	0	0	0	0	0	0	0	0
0	5896.6046	10.6574	5884.4301	5.1074	5943.5517	22.2047	5902.9042	13.2024
1	5758.9354	-7.3645	5767.0501	-3.9319	5771.9235	-0.4837	5774.0508	-0.6289
2	0.7171	-0.4876	-0.1032	-0.1059	0.0337	-0.0432	-0.0852	-0.0337
3	-0.0587	0.1286	-0.0117	0.0105	0.0200	-0.0028	0.0119	0.0053
4	-0.0083	-0.0060	-0.0039	-0.0015	-0.0003	0.0019	0.0002	0.0002
5	0.0027	0.0003	0.0043	0.0033	-0.0050	0.0050	-0.0001	-0.0024

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 213 THRU 244 JD 2443721.5 TO 2443753.5 DATES AUG 1 THRU SEPT 1

A = 16.00000000 B = -14.31250000

POWERS OF TIME COEFFICIENTS

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
	0	0	0	0
0	6085.0183	5938.9517	13.6057	0.2633
1	5775.7720	5760.8345	-5.0776	-0.0007
2	0.0	0.2812	-0.4625	0.0004
3	-0.0028	-0.0384	0.0620	0.0031
4	0.0	-0.0097	0.0028	0.0006
5	0.0013	0.0045	-0.0021	-0.0015

	VENUS GHA	VENUS DEC	MARS GHA	MARS DEC	JUPITER GHA	JUPITER DEC	SATURN GHA	SATURN DEC
	0	0	0	0	0	0	0	0
0	5896.7959	-4.5521	5897.6211	-2.8063	5966.8844	21.1356	5929.8902	11.8861
1	5761.0920	-7.8853	5766.5259	-4.1765	5772.2154	-0.6033	5773.8468	-0.7136
2	0.4690	0.2089	-0.1711	-0.0130	0.1190	-0.0203	-0.0205	-0.0112
3	0.0006	0.1159	-0.0171	0.0259	0.0100	0.0072	0.0155	-0.0038
4	0.0167	-0.0017	-0.0013	0.0009	-0.0017	0.0033	0.0012	0.0007
5	0.0043	-0.0022	0.0003	-0.0059	0.0047	-0.0021	-0.0034	0.0066

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 244 THRU 275 JD 2443752.5 TO 2443784.5 DATES SEPT 1 THRU OCT 2

A = 16.00000000 B = -16.25000000

POWERS OF TIME COEFFICIENTS

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
	0	0	0	0
0	6115.5733	5941.3078	2.4801	0.2651
1	5775.7720	5761.4295	-6.1748	0.0019
2	0.0	0.0093	-0.1026	0.0026
3	-0.0028	-0.0663	0.0570	-0.0016
4	0.0	-0.0053	-0.0014	-0.0020
5	0.0013	0.0039	0.0042	0.0005

	VENUS GHA	VENUS DEC	MARS GHA	MARS DEC	JUPITER GHA	JUPITER DEC	SATURN GHA	SATURN DEC
	0	0	0	0	0	0	0	0
0	5901.0892	-18.2286	5909.4963	-10.7931	5991.1043	19.9470	5956.7296	10.4937
1	5763.8823	-5.8038	5765.6720	-3.9865	5772.8464	-0.5978	5773.8987	-0.7045
2	1.3477	0.8775	-0.2667	0.1165	0.2100	0.0185	0.0456	0.0162
3	0.3675	0.1254	-0.0200	0.0307	0.0226	0.0070	0.0167	0.0062
4	0.0729	0.0094	-0.0012	0.0017	0.0024	0.0033	0.0012	0.0009
5	0.0116	0.0047	0.0022	-0.0035	-0.0040	0.0	-0.0039	-0.0011

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 274 THRU 305 JD 2443782.5 TO 2443814.5 DATES OCT 1 THRU NOV 1

A = 16.00000000 B = -18.12500000

POWERS OF TIME COEFFICIENTS

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
	0	0	0	0
0	6145.1425	5943.6153	-9.0398	0.2675
1	5775.7686	5760.8433	-5.8729	0.0033
2	0.0001	-0.3123	0.2751	0.0
3	0.0043	-0.0634	0.0705	-0.0061
4	-0.0001	0.0043	0.0014	0.0
5	-0.0027	0.0077	0.0008	0.0037

	VENUS GHA	VENUS DEC	MARS GHA	MARS DEC	JUPITER GHA	JUPITER DEC	SATURN GHA	SATURN DEC
	0	0	0	0	0	0	0	0
0	5916.6421	-24.9601	5919.0810	-17.6717	6016.0611	18.9570	5983.0324	9.2671
1	5775.1180	-0.5663	5764.5087	-3.2490	5773.8407	-0.4286	5774.1986	-0.5832
2	4.9413	2.2437	-0.3415	0.2805	0.3191	0.0690	0.1129	0.0466
3	0.3968	0.4239	-0.0098	0.0314	0.0189	0.0136	0.0094	-0.0040
4	-0.3992	-0.0316	0.0030	0.0020	-0.0001	0.0002	0.0002	-0.0001
5	-0.1447	-0.0635	0.0017	0.0	0.0002	-0.0041	0.0017	0.0071

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 305 THRU 336 JD 2443813.5 TO 2443845.5 DATES NOV 1 THRU DEC 2

A = 16.00000000 B = -20.06250000

POWERS OF TIME COEFFICIENTS

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
	0	0	0	0
0	5815.6975	5943.7871	-18.8412	0.2701
1	5775.7686	5759.2528	-3.9588	-0.0007
2	0.0001	-0.4531	0.7137	-0.0004
3	0.0043	0.0055	0.0768	0.0031
4	-0.0001	0.0172	-0.0023	-0.0006
5	-0.0027	0.0043	-0.0040	-0.0015

	VENUS GHA	VENUS DEC	MARS GHA	MARS DEC	JUPITER GHA	JUPITER DEC	SATURN GHA	SATURN DEC
	0	0	0	0	0	0	0	0
0	5958.8877	-17.2363	5926.5353	-22.6753	6044.2141	18.4476	6011.0494	8.3458
1	5781.6126	6.2334	5763.2177	-1.7953	5775.2860	-0.0710	5774.7671	-0.3456
2	-4.1740	-1.1924	-0.2963	0.4650	0.4195	0.1094	0.1785	0.0778
3	-1.3197	-1.2759	0.0192	0.0306	0.0092	0.0008	0.0053	0.0033
4	0.6910	0.2926	0.0035	-0.0009	-0.0045	-0.0008	0.0001	-0.0019
5	0.0359	0.1442	0.0025	-0.0028	0.0005	0.0022	0.0040	0.0006

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 335 THRU 365 JD 2443843.5 TO 2443874.5 DATES DEC 1 THRU DEC 31

A = 16.00000000 B = -21.87500000

POWERS OF TIME COEFFICIENTS

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
	0	0	0	0
0	5844.2812	5941.1769	-23.2879	0.2718
1	5775.7695	5758.0734	-0.7771	-0.0004
2	0.0005	-0.1315	0.9934	-0.0027
3	0.0025	0.0786	0.0201	0.0046
4	-0.0001	0.0055	-0.0117	0.0017
5	-0.0020	0.0057	-0.0016	-0.0036

	VENUS GHA	VENUS DEC	MARS GHA	MARS DEC	JUPITER GHA	JUPITER DEC	SATURN GHA	SATURN DEC
	0	0	0	0	0	0	0	0
0	5983.0954	-12.9294	5931.5705	-24.2526	6073.3175	18.6821	6038.4548	7.9908
1	5766.3856	-1.2954	5762.4637	0.1190	5776.8180	0.3227	5775.4963	-0.0379
2	-2.8544	-1.4232	-0.0968	0.5703	0.4008	0.0972	0.2184	0.0906
3	0.5022	0.4243	0.0386	0.0093	-0.0243	-0.0086	0.0099	0.0048
4	-0.0551	-0.0017	-0.0011	-0.0025	-0.0104	-0.0016	-0.0014	-0.0005
5	-0.0033	-0.0206	0.0035	-0.0015	0.0010	0.0	-0.0046	-0.0029

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 1 THRU 6 JD 2443509.5 TO 2443515.5 DATES JAN 1 THRU JAN 6

A = 3.00000000 B = -1.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1692.8001	-10.4113	0.9789	0.2667
1	1042.0994	-11.0599	0.0446	0.0122
2	-3.3752	2.0764	-0.0006	-0.0002
3	-0.4961	1.2281	-0.0056	-0.0015
4	0.3013	0.0939	-0.0011	-0.0003
5	0.1017	-0.0434	-0.0001	0.0

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 7 THRU 12 JD 2443515.5 TO 2443521.5 DATES JAN 7 THRU JAN 12

A = 3.00000000 B = -3.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1246.7846	-15.3444	1.0156	0.2767
1	1036.8710	8.2244	-0.0218	-0.0059
2	2.9182	4.5024	-0.0193	-0.0053
3	0.9362	-1.3533	-0.0035	-0.0010
4	-0.5022	-0.2584	-0.0002	-0.0001
5	-0.0365	0.1462	0.0055	0.0015

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 13 THRU 18 JD 2443521.5 TO 2443527.5 DATES JAN 13 THRU JAN 18

A = 3.00000000 B = -5.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1172.3261	8.1105	0.9307	0.2536
1	1046.5591	10.7694	-0.0391	-0.0106
2	0.5031	-2.0543	0.0097	0.0026
3	-0.6179	-0.5154	0.0072	0.0020
4	0.1042	0.0907	-0.0001	0.0
5	0.0191	-0.0231	-0.0040	-0.0011

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 19 THRU 24 JD 2443527.5 TO 2443533.5 DATES JAN 19 THRU JAN 24

A = 3.00000000 B = -7.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1104.6720	18.2815	0.9004	0.2453
1	1045.5511	-1.6953	0.0040	0.0011
2	0.0646	-3.6315	0.0097	0.0026
3	0.3267	0.0761	0.0003	0.0001
4	-0.0084	0.1151	-0.0018	-0.0005
5	-0.0430	0.0056	-0.0005	-0.0001

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 25 THRU 30 JD 2443533.5 TO 2443539.5 DATES JAN 25 THRU JAN 30

A = 3.00000000 B = -9.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1397.3389	2.7633	0.9333	0.2543
1	1046.7636	-11.8904	0.0257	0.0070
2	-0.5113	-0.8233	0.0039	0.0011
3	-0.6102	0.7265	-0.0011	-0.0003
4	-0.0849	0.0530	0.0005	0.0001
5	0.0263	0.0063	0.0009	0.0002

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 31 THRU 36 JD 2443539.5 TO 2443545.5 DATES JAN 31 THRU FEB 5

A = 3.00000000 B = -11.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1323.7594	-17.4597	0.9956	0.2713
1	1037.9464	-4.3955	0.0287	0.0078
2	-2.4669	4.9148	-0.0080	-0.0022
3	0.8579	0.8514	-0.0044	-0.0012
4	0.3804	-0.2595	-0.0004	-0.0001
5	-0.0564	-0.0951	0.0003	0.0001

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 37 THRU 42 JD 2443545.5 TO 2443551.5 DATES FEB 6 THRU FEB 11

A = 3.00000000 B = -13.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1239.4942	-6.1180	0.9904	0.2699
1	1041.7278	12.7962	-0.0369	-0.0100
2	2.6153	1.0644	-0.0135	-0.0037
3	-0.3468	-1.3634	0.0039	0.0011
4	-0.2306	0.1033	0.0023	0.0006
5	0.0792	0.0599	0.0005	0.0001

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 43 THRU 48 JD 2443551.5 TO 2443557.5 DATES FEB 12 THRU FEB 17

A = 3.00000000 B = -15.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1169.2037	15.5724	0.9132	0.2488
1	1045.9670	6.1239	-0.0244	-0.0067
2	-0.1595	-3.2461	0.0117	0.0032
3	-0.1474	-0.2625	0.0042	0.0011
4	0.1119	0.0732	-0.0008	-0.0002
5	-0.0023	-0.0027	-0.0023	-0.0006

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 49 THRU 54 JD 2443557.5 TO 2443563.5 DATES FEB 18 THRU FEB 23

A = 3.00000000 B = -17.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1100.7814	13.8936	0.9131	0.2488
1	1046.1062	-7.6230	0.0213	0.0058
2	0.3500	-2.9263	0.0067	0.0018
3	-0.0329	0.4344	-0.0106	-0.0029
4	-0.0983	0.0967	-0.0010	-0.0003
5	-0.0135	-0.0055	0.0067	0.0018

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 55 THRU 60 JD 2443563.5 TO 2443569.5 DATES FEB 24 THRU MAR 1

A = 3.00000000 B = -19.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1392.4262	-8.1667	0.9600	0.2616
1	1043.8849	-11.3604	0.0243	0.0066
2	-1.9534	1.6391	-0.0002	-0.0001
3	-0.4382	0.9987	-0.0044	-0.0012
4	0.1206	0.0195	-0.0008	-0.0002
5	0.0536	-0.0167	0.0032	0.0009

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 61 THRU 66 JD 2443569.5 TO 2443575.5 DATES MAR 2 THRU MAR 7

A = 3.00000000 B = -21.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1312.3237	-17.0059	0.9958	0.2713
1	1038.0410	5.0320	0.0043	0.0012
2	0.8371	4.9438	-0.0121	-0.0033
3	0.9489	-0.5590	0.0	0.0
4	-0.1640	-0.3175	0.0015	0.0004
5	-0.0854	0.0346	-0.0014	-0.0004

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 67 THRU 72 JD 2443575.5 TO 2443581.5 DATES MAR 8 THRU MAR 13

A = 3.00000000 B = -23.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1235.1272	4.8338	0.9573	0.2608
1	1044.5499	12.1245	-0.0376	-0.0103
2	0.9012	-1.5822	-0.0016	-0.0004
3	-0.4203	-0.8567	0.0045	0.0012
4	0.0336	0.1474	-0.0008	-0.0002
5	0.0304	0.0034	0.0001	0.0

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 73 THRU 78 JD 2443581.5 TO 2443587.5 DATES MAR 14 THRU MAR 19

A = 3.00000000 B = -25.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MCON S D
	0	0	0	0
0	1165.6759	18.1972	0.9040	0.2463
1	1045.5820	-0.0552	-0.0036	-0.0010
2	0.2177	-3.6163	0.0145	0.0039
3	0.1117	0.0395	-0.0051	-0.0014
4	-0.0060	0.0754	-0.0018	-0.0005
5	-0.0286	0.0018	0.0031	0.0008

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 79 THRU 84 JD 2443587.5 TO 2443593.5 DATES MAR 20 THRU MAR 25

A = 3.00000000 B = -27.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1097.8112	5.1591	0.9373	0.2554
1	1046.0180	-11.5783	0.0298	0.0081
2	-0.6192	-1.4675	0.0047	0.0013
3	-0.4383	0.7370	0.0002	0.0001
4	-0.0431	0.1098	-0.0029	-0.0008
5	0.0158	0.0001	-0.0020	-0.0006

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 85 THRU 90 JD 2443593.5 TO 2443599.5 DATES MAR 26 THRU MAR 31

A = 3.00000000 B = -29.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1384.0249	-16.4210	0.9840	0.2681
1	1039.2746	-5.8432	0.0083	0.0023
2	-1.6118	4.4672	-0.0052	-0.0014
3	0.6656	0.7525	0.0068	0.0018
4	0.2254	-0.2344	-0.0014	-0.0004
5	-0.0480	-0.0578	-0.0050	-0.0014

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC CATA FOR YEAR 1978

DAYS 91 THRU 96 JD 2443599.5 TO 2443605.5 DATES APR 1 THRU APR 6

A = 3.00000000 B = -31.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1302.8563	-9.0982	0.9784	0.2666
1	1042.1935	11.4066	-0.0148	-0.0040
2	1.8300	2.1199	-0.0085	-0.0023
3	-0.2635	-1.1191	-0.0028	-0.0008
4	-0.1664	-0.0323	0.0022	0.0006
5	0.0599	0.0379	0.0027	0.0007

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 97 THRU 102 JD 2443605.5 TO 2443611.5 DATES APR 7 THRU APR 12

A = 3.00000000 B = -33.33333333

A PARTIAL ECLIPSE OF THE SUN OCCURS ON APRIL 7. THE
ECLIPSE BEGINS AT 13 02 GMT AND ENDS AT 17 04 GMT.

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 103 THRU 108 JD 2443611.5 TO 2443617.5 DATES APR 13 THRU APR 18

A = 3.00000000 B = -35.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1162.4036	15.4203	0.9073	0.2472
1	1046.4162	-6.0946	0.0157	0.0043
2	0.5020	-3.0829	0.0115	0.0031
3	-0.1754	0.3117	-0.0061	-0.0017
4	-0.1079	0.0539	0.0011	0.0003
5	-0.0012	0.0009	0.0032	0.0009

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 109 THRU 114 JD 2443617.5 TO 2443623.5 DATES APR 19 THRU APR 24

A = 3.00000000 B = -37.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1094.2726	-5.5408	0.9702	0.2643
1	1043.4256	-12.3376	0.0352	0.0096
2	-2.3478	0.8347	-0.0058	-0.0016
3	-0.4365	1.1629	-0.0040	-0.0011
4	0.1661	0.1035	-0.0005	-0.0001
5	0.0635	-0.0388	0.0010	0.0003

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 115 THRU 120 JD 2443623.5 TO 2443629.5 DATES APR 25 THRU APR 30

A = 3.00000000 B = -39.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1372.6329	-17.7139	0.9951	0.2711
1	1037.8075	3.4012	-0.0134	-0.0036
2	1.5017	5.0923	-0.0099	-0.0027
3	1.0099	-0.5850	0.0076	0.0021
4	-0.2686	-0.3074	0.0008	0.0002
5	-0.0937	0.0725	-0.0049	-0.0013

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 121 THRU 126 JD 2443629.5 TO 2443635.5 DATES MAY 1 THRU MAY 6

A = 3.00000000 B = -41.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1296.7163	2.1078	0.9514	0.2592
1	1045.3135	12.3417	-0.0255	-0.0070
2	0.5973	-0.7389	-0.0023	-0.0006
3	-0.5563	-0.8664	0.0016	0.0004
4	0.0705	0.0665	0.0023	0.0006
5	0.0351	0.0004	-0.0004	-0.0001

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 127 THRU 132 JD 2443635.5 TO 2443641.5 DATES MAY 7 THRU MAY 12

A = 3.00000000 B = -43.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1227.2431	18.1467	0.9074	0.2472
1	1045.0796	1.6514	-0.0125	-0.0034
2	0.3197	-3.7210	0.0053	0.0014
3	0.3364	-0.0051	-0.0026	-0.0007
4	-0.0157	0.1221	0.0024	0.0007
5	-0.0458	-0.0107	0.0038	0.0010

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 133 THRU 138 JD 2443641.5 TO 2443647.5 DATES MAY 13 THRU MAY 18

A = 3.00000000 B = -45.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1159.9450	8.0485	0.9220	0.2512
1	1047.2297	-10.4892	0.0321	0.0088
2	-0.3064	-1.9086	0.0098	0.0027
3	-0.6206	0.4992	-0.0036	-0.0010
4	-0.0890	0.0701	0.0007	0.0002
5	0.0223	0.0163	0.0007	0.0002

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 139 THRU 144 JD 2443647.5 TO 2443653.5 DATES MAY 19 THRU MAY 24

A = 3.00000000 B = -47.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1087.7294	-14.8136	1.0012	0.2728
1	1038.3518	-8.3716	0.0293	0.0080
2	-3.0071	4.0308	-0.0183	-0.0050
3	0.6486	1.2985	-0.0067	-0.0018
4	0.4523	-0.1789	0.0037	0.0010
5	-0.0088	-0.1251	0.0024	0.0007

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 145 THRU 150 JD 2443653.5 TO 2443659.5 DATES MAY 25 THRU MAY 30

A = 3.00000000 B = -49.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1362.4502	-11.0990	0.9868	0.2689
1	1041.1930	10.7758	-0.0352	-0.0096
2	3.0173	2.5055	-0.0058	-0.0016
3	-0.3114	-1.2440	0.0085	0.0023
4	-0.3266	0.0254	0.0006	0.0002
5	0.0946	0.0597	-0.0030	-0.0008

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 151 THRU 156 JD 2443659.5 TO 2443665.5 DATES MAY 31 THRU JUNE

A = 3.00000000 B = -51.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1292.0152	12.0953	0.9249	0.2520
1	1045.8354	9.0334	-0.0245	-0.0067
2	-0.4134	-2.6550	0.0023	0.0006
3	-0.1869	-0.5408	0.0049	0.0013
4	0.1697	0.0818	0.0022	0.0006
5	0.0058	0.0062	-0.0036	-0.0010

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 157 THRU 162 JD 2443665.5 TO 2443671.5 DATES JUNE 6 THRU JUNE 11

A = 3.00000000 B = -53.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1222.9668	16.8340	0.8996	0.2451
1	1046.2679	-4.6866	0.0015	0.0004
2	0.9420	-3.2366	0.0084	0.0023
3	0.0801	0.3511	0.0027	0.0007
4	-0.1494	0.0683	0.0007	0.0002
5	-0.0140	-0.0207	-0.0017	-0.0005

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 163 THRU 168 JD 2443671.5 TO 2443677.5 DATES JUNE 12 THRU JUNE 17

A = 3.00000000 B = -55.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1157.3668	-2.0427	0.9455	0.2576
1	1046.0622	-12.1881	0.0439	0.0120
2	-2.0305	-0.1552	0.0068	0.0018
3	-0.8478	0.8023	0.0005	0.0001
4	0.0292	0.1387	-0.0003	-0.0001
5	0.0578	0.0170	-0.0048	-0.0013

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 169 THRU 174 JD 2443677.5 TO 2443683.5 DATES JUNE 18 THRU JUNE 23

A = 3.00000000 B = -57.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1077.4088	-18.4241	1.0211	0.2782
1	1034.8632	0.4671	0.0075	0.0020
2	-0.2451	6.0034	-0.0231	-0.0063
3	1.9140	0.0214	0.0013	0.0004
4	0.0133	-0.5309	0.0012	0.0003
5	-0.2391	-0.0102	-0.0012	-0.0003

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 175 THRU 180 JD 2443683.5 TO 2443689.5 DATES JUNE 24 THRU JUNE 29

A = 3.00000000 B = -59.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1355.7851	-0.2527	0.9643	0.2628
1	1044.5781	12.7649	-0.0450	-0.0123
2	1.7937	-0.5214	0.0034	0.0009
3	-0.7901	-0.9091	0.0086	0.0024
4	-0.0140	0.1456	-0.0012	-0.0003
5	0.0608	-0.0136	-0.0035	-0.0010

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 181 THRU 186 JD 2443689.5 TO 2443695.5 DATES JUNE 30 THRU JULY 5

A = 3.00000000 B = -61.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1287.1356	17.7359	0.9059	0.2468
1	1045.3941	3.1926	-0.0145	-0.0039
2	-0.1849	-3.5948	0.0078	0.0021
3	0.2809	-0.1650	0.0007	0.0002
4	0.0982	0.1114	-0.0011	-0.0003
5	-0.0391	0.0114	-0.0009	-0.0002

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 187 THRU 192 JD 2443695.5 TO 2443701.5 DATES JULY 6 THRU JULY 11

A = 3.00000000 B = -63.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1219.6365	10.3293	0.9066	0.2470
1	1047.7580	-9.4786	0.0148	0.0040
2	0.5588	-2.0286	0.0079	0.0022
3	-0.3945	0.5198	0.0024	0.0007
4	-0.1396	0.0283	0.0004	0.0001
5	0.0072	-0.0032	-0.0005	-0.0001

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 193 THRU 198 JD 2443701.5 TO 2443707.5 DATES JULY 12 THRU JULY 17

A = 3.00000000 B = -65.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1152.4588	-12.0064	0.9732	0.2652
1	1042.1290	-9.9599	0.0475	0.0129
2	-3.5301	2.4768	-0.0031	-0.0008
3	-0.4022	1.1846	-0.0081	-0.0022
4	0.3289	0.0697	0.0025	0.0007
5	0.1043	-0.0520	0.0022	0.0006

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 199 THRU 204 JD 2443707.5 TO 2443713.5 DATES JULY 18 THRU JULY 23

A = 3.00000000 B = -67.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1066.6524	-13.9960	1.0194	0.2777
1	1037.0592	9.4801	-0.0188	-0.0051
2	2.7145	4.1201	-0.0194	-0.0053
3	0.7592	-1.4398	0.0056	0.0015
4	-0.4746	-0.2270	-0.0012	-0.0003
5	-0.0125	0.1448	-0.0017	-0.0005

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 205 THRU 210 JD 2443713.5 TO 2443719.5 DATES JULY 24 THRU JULY 29

A = 3.00000000 B = -69.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1351.2012	10.1346	0.9382	0.2556
1	1045.4888	10.1250	-0.0393	-0.0107
2	0.4114	-2.5537	0.0096	0.0026
3	-0.4658	-0.5060	0.0001	0.0
4	0.1266	0.1069	-0.0016	-0.0004
5	0.0158	-0.0126	0.0018	0.0005

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 211 THRU 216 JD 2443719.5 TO 2443725.5 DATES JULY 30 THRU AUG 4

A = 3.00000000 B = -71.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1282.3672	17.5589	0.8998	0.2452
1	1045.9426	-3.3072	-0.0015	-0.0004
2	0.6168	-3.4294	0.0058	0.0016
3	0.2329	0.2452	0.0002	0.0
4	-0.0643	0.0974	0.0015	0.0004
5	-0.0337	-0.0061	-0.0005	-0.0001

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 217 THRU 222 JD 2443725.5 TO 2443731.5 DATES AUG 5 THRU AUG 10

A = 3.00000000 B = -73.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1216.7874	0.4653	0.9248	0.2520
1	1047.5033	-11.7025	0.0271	0.0074
2	-0.8109	-0.3654	0.0044	0.0012
3	-0.6684	0.6812	-0.0071	-0.0019
4	-0.0526	0.0496	0.0022	0.0006
5	0.0277	0.0125	0.0055	0.0015

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 223 THRU 228 JD 2443731.5 TO 2443737.5 DATES AUG 11 THRU AUG 16

A = 3.00000000 B = -75.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1143.5254	-17.8686	0.9949	0.2711
1	1037.7675	-2.8613	0.0361	0.0098
2	-2.4236	5.0856	-0.0080	-0.0022
3	0.9623	0.7510	-0.0039	-0.0011
4	0.3418	-0.2857	-0.0002	-0.0001
5	-0.0751	-0.0985	-0.0022	-0.0006

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 229 THRU 234 JD 2443737.5 TO 2443743.5 DATES AUG 17 THRU AUG 22

A = 3.00000000 B = -77.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1058.9896	-3.8855	0.9993	0.2723
1	1041.2693	13.3727	-0.0388	-0.0106
2	2.2705	0.5140	-0.0128	-0.0035
3	-0.3708	-1.3963	0.0118	0.0032
4	-0.1838	0.1241	-0.0009	-0.0002
5	0.0806	0.0526	-0.0040	-0.0011

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 235 THRU 240 JD 2443743.5 TO 2443749.5 DATES AUG 23 THRU AUG 28

A = 3.00000000 B = -79.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1346.9031	16.7410	0.9172	0.2499
1	1045.1365	4.6190	-0.0286	-0.0078
2	0.1988	-3.5828	0.0089	0.0024
3	0.0137	-0.1422	0.0009	0.0002
4	0.0907	0.0969	0.0024	0.0007
5	-0.0127	-0.0031	0.0010	0.0003

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 241 THRU 246 JD 2443749.5 TO 2443755.5 DATES AUG 29 THRU SEPT 3

A = 3.00000000 B = -81.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1278.8448	11.9288	0.9063	0.2469
1	1047.1605	-8.6337	0.0142	0.0039
2	0.5406	-2.4004	0.0087	0.0024
3	-0.1979	0.5062	-0.0045	-0.0012
4	-0.0977	0.0661	-0.0014	-0.0004
5	-0.0049	-0.0063	0.0023	0.0006

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 247 THRU 252 JD 2443755.5 TO 2443761.5 DATES SEPT 4 THRU SEPT 9

A = 3.00000000 B = -83.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1212.3181	-9.9856	0.9501	0.2589
1	1044.3460	-10.3714	0.0277	0.0075
2	-2.2324	1.9599	0.0003	0.0001
3	-0.4096	0.9233	-0.0022	-0.0006
4	0.1418	0.0227	0.0013	0.0004
5	0.0455	-0.0148	0.0009	0.0003

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 253 THRU 258 JD 2443761.5 TO 2443767.5 DATES SEPT 10 THRU SEPT 15

A = 3.00000000 B = -85.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1132.3883	-16.1159	1.0015	0.2729
1	1037.8955	6.4680	0.0152	0.0041
2	0.7059	4.8177	-0.0114	-0.0031
3	0.8911	-0.6659	-0.0077	-0.0021
4	-0.1804	-0.3302	-0.0011	-0.0003
5	-0.0821	0.0378	0.0029	0.0008

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 259 THRU 264 JD 2443767.5 TO 2443773.5 DATES SEPT 16 THRU SEPT 21

A = 3.00000000 B = -87.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1413.9262	7.2011	0.9675	0.2636
1	1043.3849	11.7927	-0.0407	-0.0111
2	0.7463	-2.2207	-0.0031	-0.0009
3	-0.2956	-0.8488	0.0046	0.0013
4	0.0632	0.1804	0.0001	0.0
5	0.0265	0.0041	0.0	0.0

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 265 THRU 270 JD 2443773.5 TO 2443779.5 DATES SEPT 22 THRU SEPT 27

A = 3.00000000 B = -89.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1342.7692	17.9177	0.9048	0.2465
1	1045.5969	-1.8734	-0.0102	-0.0028
2	0.7911	-3.5483	0.0153	0.0042
3	0.0737	0.2099	-0.0035	-0.0009
4	-0.0571	0.0700	-0.0027	-0.0007
5	-0.0193	-0.0055	0.0032	0.0009

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 271 THRU 276 JD 2443779.5 TO 2443785.5 DATES SEPT 28 THRU OCT 3

A = 3.00000000 B = -91.33333333

A PARTIAL ECLIPSE OF THE SUN OCCURS ON OCTOBER 2. THE ECLIPSE BEGINS AT 04 31 GMT AND ENDS AT 08 25 GMT.

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 277 THRU 282 JD 2443785.5 TO 2443791.5 DATES OCT 4 THRU OCT 9

A = 3.00000000 B = -93.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1204.0569	-17.1851	0.9756	0.2658
1	1039.7643	-4.3772	0.0194	0.0053
2	-1.6787	4.5202	-0.0055	-0.0015
3	0.6602	0.6363	-0.0069	-0.0019
4	0.1982	-0.2206	0.0013	0.0003
5	-0.0506	-0.0476	0.0051	0.0014

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 283 THRU 288 JD 2443791.5 TO 2443797.5 DATES OCT 10 THRU OCT 15

A = 3.00000000 B = -95.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1123.1474	-7.2959	0.9895	0.2696
1	1041.6560	12.3057	-0.0089	-0.0024
2	1.3915	1.8084	-0.0131	-0.0036
3	-0.2613	-1.2144	-0.0019	-0.0005
4	-0.1398	-0.0478	0.0029	0.0008
5	0.0544	0.0463	0.0020	0.0005

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 289 THRU 294 JD 2443797.5 TO 2443803.5 DATES OCT 16 THRU OCT 21

A = 3.00000000 B = -97.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1409.4062	15.3969	0.9366	0.2552
1	1043.7198	6.6027	-0.0353	-0.0096
2	0.2695	-3.6819	0.0031	0.0008
3	0.2138	-0.3138	0.0094	0.0026
4	0.0779	0.1718	0.0	0.0
5	-0.0291	-0.0045	-0.0042	-0.0012

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 295 THRU 300 JD 2443803.5 TO 2443809.5 DATES OCT 22 THRU OCT 27

A = 3.00000000 B = -99.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1339.7911	13.7350	0.9057	0.2468
1	1047.1224	-7.4803	0.0103	0.0028
2	0.7745	-2.6662	0.0096	0.0026
3	-0.3321	0.4131	-0.0078	-0.0021
4	-0.1075	0.0332	0.0025	0.0007
5	0.0101	-0.0015	0.0047	0.0013

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 301 THRU 306 JD 2443809.5 TO 2443815.5 DATES OCT 28 THRU NOV 2

A = 3.00000000 B = -101.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1273.2040	-7.8529	0.9575	0.2609
1	1044.0036	-11.4856	0.0315	0.0086
2	-2.4481	1.3843	-0.0024	-0.0006
3	-0.3741	1.0866	-0.0005	-0.0001
4	0.1895	0.0650	-0.0006	-0.0002
5	0.0576	-0.0384	-0.0018	-0.0005

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC CATA FOR YEAR 1978

DAYS 307 THRU 312 JD 2443815.5 TO 2443821.5 DATES NOV 3 THRU NOV 8

A = 3.00000000 B = -103.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON CEC	MOON H P	MOON S D
	0	0	0	0
0	1192.8385	-17.2030	0.9903	0.2698
1	1038.5138	4.7616	-0.0011	-0.0003
2	1.3305	4.8361	-0.0079	-0.0021
3	0.8165	-0.6177	-0.0053	-0.0014
4	-0.2701	-0.2726	0.0003	0.0001
5	-0.0620	0.0585	0.0053	0.0014

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 313 THRU 318 JD 2443821.5 TO 2443827.5 DATES NOV 9 THRU NOV 14

A = 3.00000000 B = -105.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1116.6748	4.2166	0.9636	0.2626
1	1044.1980	12.4659	-0.0230	-0.0063
2	0.1709	-1.2029	-0.0063	-0.0017
3	-0.4439	-0.9598	0.0011	0.0003
4	0.1095	0.0728	0.0019	0.0005
5	0.0331	0.0168	0.0003	0.0001

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 319 THRU 324 JD 2443827.5 TO 2443833.5 DATES NOV 15 THRU NOV 20

A = 3.00000000 B = -107.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1404.6855	18.3999	0.9133	0.2488
1	1044.4941	-0.1039	-0.0217	-0.0059
2	0.9693	-3.8472	0.0076	0.0021
3	0.3716	0.1952	0.0109	0.0030
4	-0.0908	0.1246	-0.0003	-0.0001
5	-0.0432	-0.0236	-0.0067	-0.0018

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 325 THRU 330 JD 2443833.5 TO 2443839.5 DATES NOV 21 THRU NOV 26

A = 3.00000000 B = -109.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1338.1368	5.5946	0.9167	0.2498
1	1047.9880	-11.0015	0.0253	0.0069
2	-0.3944	-1.3703	0.0126	0.0034
3	-0.7109	0.5143	0.0024	0.0007
4	-0.0581	0.0594	-0.0019	-0.0005
5	0.0203	0.0263	-0.0036	-0.0010

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 331 THRU 336 JD 2443839.5 TO 2443845.5 DATES NOV 27 THRU DEC 2

A = 3.C0000000 B = -111.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1266.8569	-16.1098	0.9913	0.2701
1	1038.7040	-6.8236	0.0306	0.0083
2	-2.8441	4.3249	-0.0148	-0.0040
3	0.7784	1.1184	-0.0066	-0.0018
4	0.4176	-0.2091	0.0019	0.0005
5	-0.0357	-0.1123	0.0028	0.0008

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 337 THRU 342 JD 2443845.5 TO 2443851.5 DATES DEC 3 THRU DEC 8

A = 3.00000000 B = -113.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1182.8111	-9.5571	0.9883	0.2693
1	1041.5122	11.6026	-0.0271	-0.0074
2	2.5422	2.1447	-0.0056	-0.0015
3	-0.3977	-1.2195	0.0094	0.0026
4	-0.2747	0.0278	0.0	0.0
5	0.0888	0.0434	-0.0048	-0.0013

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC CATA FOR YEAR 1978

DAYS 343 THRU 348 JD 2443851.5 TO 2443857.5 DATES DEC 9 THRU DEC 14

A = 3.00000000 B = -115.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1111.0942	13.7910	0.9343	0.2546
1	1044.5107	8.2285	-0.0240	-0.0065
2	-0.4664	-3.1579	0.0024	0.0007
3	0.0316	-0.5329	0.0044	0.0012
4	0.1863	0.1182	-0.0004	-0.0001
5	-0.0108	0.0135	-0.0039	-0.0011

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 349 THRU 354 JD 2443857.5 TO 2443863.5 DATES DEC 15 THRU DEC 20

A = 3.00000000 B = -117.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1400.6894	15.6348	0.9016	0.2457
1	1046.6127	-6.1742	-0.0034	-0.0009
2	1.3817	-2.9281	0.0097	0.0026
3	-0.0646	0.4831	-0.0017	-0.0005
4	-0.1779	0.0380	-0.0012	-0.0003
5	-0.0001	-0.0237	0.0028	0.0008

CHEBYSHEV APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1978

DAYS 355 THRU 360 JD 2443863.5 TO 2443869.5 DATES DEC 21 THRU DEC 26

A = 3.00000000 B = -119.33333333

POWERS OF TIME COEFFICIENTS

	MOON GHA	MOON DEC	MOON H P	MOON S D
	0	0	0	0
0	1336.3592	-4.4113	0.9372	0.2554
1	1046.5418	-11.7575	0.0396	0.0108
2	-2.2261	0.3563	0.0076	0.0021
3	-0.8484	0.7764	0.0026	0.0007
4	0.0596	0.1257	0.0009	0.0003
5	0.0586	0.0219	-0.0045	-0.0012

DAYS 360 THRU 365 JD 2443868.5 TO 2443874.5 DATES DEC 26 THRU DEC 31

A = 3.00000000 B = -121.00000000

POWERS OF TIME COEFFICIENTS

MOON GHA	MOON DEC	MOON H P	MOON S D
0	0	0	0
1271.8409	-18.3554	1.0098	0.2751
1036.0261	-1.8079	0.0271	0.0074
-1.8322	5.6506	-0.0239	-0.0065
1.6076	0.5923	-0.0008	-0.0002
0.2822	-0.4402	0.0060	0.0016
-0.1775	-0.0943	-0.0028	-0.0007

Section D: ASTRONOMICAL TABLES

With two exceptions the series in this section provide data referred to the true equator and equinox of date. The exceptions are

1. the Moon's geocentric, rectangular coordinates (X, Y, Z), which are referred to the mean equator and equinox of 1950.0;
2. the right ascension and declination of Pluto, which are astrometric (*i.e.*, free of the effect of stellar aberration, except for the elliptic part) and are referred to the mean equator and equinox of 1950.0.

The unit of distance for the Sun and planets is the Astronomical Unit; the unit of distance for the Moon is the Earth's radius.

CHEBYSHEV APPROXIMATION OF SIDEREAL TIME FOR YEAR 1978

DAYS 1 THRU 95 JD 2443509.5 TO 2443604.5 DATES JAN 1 THRU APR 5

A = 47.50000000 B = -1.02105263

CHEBYSHEV COEFFICIENTS

	APP S T	EQ OF EQ	NUT LON	NUT OBL
	H	S	"	"
0	19.61466720	0.3717	6.0773	-18.1906
1	3.12119454	-0.0795	-1.2990	0.5244
2	-0.00001112	-0.0400	-0.6544	-0.1166
3	0.00000262	0.0094	0.1544	-0.0838
4	0.00000073	0.0026	0.0427	0.0324
5	0.00000056	0.0020	0.0327	0.0018
6	0.00000017	0.0006	0.0099	0.0231
7	-0.00000026	-0.0009	-0.0154	0.0015
8	0.00000035	0.0013	0.0208	0.0189
9	-0.00000137	-0.0049	-0.0804	0.0044
10	-0.00000010	-0.0003	-0.0057	0.0055
11	-0.00000076	-0.0027	-0.0450	0.0037
12	-0.00000007	-0.0002	-0.0040	-0.0231
13	-0.00000015	-0.0005	-0.0090	0.0014
14	-0.00000023	-0.0008	-0.0135	-0.0247
15	0.00000120	0.0043	0.0708	-0.0042
16	0.00000003	0.0001	0.0015	0.0137
17	0.00000033	0.0012	0.0194	-0.0023
18	0.00000020	0.0007	0.0117	0.0261
19	-0.00000133	-0.0048	-0.0785	0.0039
20	-0.00000017	-0.0006	-0.0101	-0.0311
21	0.00000103	0.0037	0.0608	-0.0033
22	0.00000016	0.0006	0.0092	0.0197
23	-0.00000061	-0.0022	-0.0361	0.0031
24	-0.00000011	-0.0004	-0.0064	-0.0114
25	0.00000032	0.0011	0.0187	-0.0013
26	0.00000001	0.0	0.0007	0.0042
27	-0.00000004	-0.0001	-0.0024	-0.0005
28	0.00000004	0.0002	0.0026	0.0015
29	-0.00000011	-0.0004	-0.0063	0.0012
30	-0.00000006	-0.0002	-0.0035	-0.0031
31	0.00000011	0.0004	0.0066	-0.0014
32	0.00000006	0.0002	0.0034	0.0024
33	-0.00000008	-0.0003	-0.0045	0.0011
34	-0.00000004	-0.0001	-0.0022	-0.0015
35	0.00000005	0.0002	0.0027	-0.0005

CHEBYSHEV APPROXIMATION OF SIDEREAL TIME FOR YEAR 1978

DAYS 91 THRU 185 JD 2443599.5 TO 2443694.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.91578947

CHEBYSHEV COEFFICIENTS

	APP S T	EQ OF EQ	NUT LON	NUT OBL
	H	S	"	"
0	31.44235163	0.0701	1.1457	-18.7716
1	3.12121160	-0.0181	-0.2954	-0.6088
2	0.00001053	0.0379	0.6195	0.1081
3	-0.00000189	-0.0068	-0.1111	0.0650
4	-0.00000010	-0.0003	-0.0056	-0.0260
5	-0.00000030	-0.0011	-0.0177	-0.0058
6	0.00000015	0.0005	0.0088	-0.0209
7	0.00000004	0.0001	0.0024	0.0036
8	-0.00000005	-0.0002	-0.0031	-0.0183
9	0.00000077	0.0028	0.0452	0.0122
10	0.00000049	0.0018	0.0288	-0.0052
11	0.00000088	0.0032	0.0517	0.0093
12	-0.00000055	-0.0020	-0.0325	0.0178
13	0.00000008	0.0003	0.0050	0.0015
14	-0.00000043	-0.0015	-0.0253	0.0201
15	-0.00000100	-0.0036	-0.0587	-0.0126
16	0.00000019	0.0007	0.0111	-0.0135
17	-0.00000019	-0.0007	-0.0114	-0.0047
18	0.00000051	0.0018	0.0298	-0.0213
19	0.00000128	0.0046	0.0753	0.0133
20	-0.00000049	-0.0018	-0.0288	0.0324
21	-0.00000113	-0.0041	-0.0664	-0.0088
22	0.00000030	0.0011	0.0175	-0.0197
23	0.00000049	0.0018	0.0288	0.0064
24	-0.00000024	-0.0009	-0.0144	0.0063
25	-0.00000014	-0.0005	-0.0080	-0.0048
26	0.00000012	0.0004	0.0069	-0.0022
27	0.00000009	0.0003	0.0052	0.0004
28	0.00000007	0.0003	0.0042	0.0022
29	-0.00000009	-0.0003	-0.0053	0.0031
30	-0.00000014	-0.0005	-0.0085	-0.0019
31	0.00000006	0.0002	0.0037	-0.0032
32	0.00000010	0.0004	0.0058	0.0012
33	-0.00000004	-0.0002	-0.0026	0.0016
34	-0.00000004	-0.0002	-0.0025	-0.0009
35	0.00000003	0.0001	0.0017	-0.0007

DAYS 182 THRU 276 JD 2443690.5 TO 2443785.5 DATES JULY 1 THRU OCT 3

A = 47.50000000 B = -4.83157895

CHEBYSHEV COEFFICIENTS

	APP S T	EQ OF EQ	NUT LON	NUT OBL
	H	S	''	''
0	43.40151950	-0.0019	-0.0316	-18.4165
1	3.12119411	-0.0810	-1.3244	0.6265
2	-0.00001093	-0.0394	-0.6434	-0.0830
3	0.00000072	0.0026	0.0426	-0.0576
4	-0.00000009	-0.0003	-0.0054	0.0071
5	-0.00000041	-0.0015	-0.0241	0.0141
6	-0.00000086	-0.0031	-0.0508	0.0045
7	-0.00000019	-0.0007	-0.0113	-0.0027
8	-0.00000084	-0.0030	-0.0494	0.0044
9	0.00000046	0.0017	0.0270	-0.0199
10	-0.00000021	-0.0008	-0.0124	-0.0002
11	-0.00000055	-0.0020	-0.0321	-0.0204
12	0.00000073	0.0026	0.0430	-0.0035
13	0.00000007	0.0002	0.0040	-0.0026
14	0.00000081	0.0029	0.0479	-0.0042
15	0.00000020	0.0007	0.0117	0.0250
16	-0.00000060	-0.0022	-0.0355	0.0025
17	0.00000009	0.0003	0.0052	0.0036
18	-0.00000086	-0.0031	-0.0508	0.0045
19	-0.00000030	-0.0011	-0.0175	-0.0329
20	0.00000143	0.0052	0.0843	-0.0060
21	0.00000023	0.0008	0.0133	0.0306
22	-0.00000089	-0.0032	-0.0521	0.0034
23	-0.00000010	-0.0004	-0.0058	-0.0126
24	0.00000023	0.0008	0.0133	-0.0013
25	0.00000004	0.0002	0.0025	0.0017
26	-0.00000003	-0.0001	-0.0020	0.0008
27	-0.00000003	-0.0001	-0.0019	-0.0018
28	0.00000013	0.0005	0.0079	-0.0006
29	0.00000002	0.0001	0.0011	0.0044
30	-0.00000019	-0.0007	-0.0111	0.0002
31	0.0	0.0	0.0	-0.0041
32	0.00000013	0.0005	0.0074	0.0002
33	-0.00000001	0.0	-0.0005	0.0020
34	-0.00000005	-0.0002	-0.0027	-0.0002
35	0.0	0.0	0.0001	-0.0007

CHEBYSHEV APPROXIMATION OF SIDEREAL TIME FOR YEAR 1978

DAYS 274 THRU 368 JD 2443782.5 TO 2443877.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.76842105

CHEBYSHEV COEFFICIENTS

	APP S T	EQ OF EQ	NUT LON	NUT OBL
	H	S	"	"
0	7.49204071	-0.3126	-5.1115	-18.6313
1	3.12121447	-0.0077	-0.1265	-0.5667
2	0.00001181	0.0425	0.6949	0.1258
3	-0.00000028	-0.0010	-0.0164	0.0845
4	-0.00000044	-0.0016	-0.0260	0.0155
5	0.00000064	0.0023	0.0377	-0.0045
6	0.00000062	0.0022	0.0366	0.0232
7	-0.00000016	-0.0006	-0.0092	0.0034
8	0.00000043	0.0015	0.0250	0.0193
9	-0.00000119	-0.0043	-0.0703	0.0082
10	-0.00000033	-0.0012	-0.0192	0.0059
11	-0.00000081	-0.0029	-0.0477	0.0079
12	-0.00000022	-0.0008	-0.0131	-0.0211
13	-0.00000021	-0.0008	-0.0124	-0.0001
14	-0.00000035	-0.0013	-0.0205	-0.0237
15	0.00000111	0.0040	0.0651	-0.0097
16	0.00000020	0.0007	0.0118	0.0126
17	0.00000035	0.0012	0.0204	-0.0037
18	0.00000033	0.0012	0.0197	0.0242
19	-0.00000130	-0.0047	-0.0762	0.0095
20	-0.00000030	-0.0011	-0.0177	-0.0310
21	0.00000108	0.0039	0.0635	-0.0055
22	0.00000018	0.0007	0.0108	0.0203
23	-0.00000061	-0.0022	-0.0356	0.0047
24	-0.00000019	-0.0007	-0.0110	-0.0099
25	0.00000025	0.0009	0.0146	-0.0038
26	0.00000009	0.0003	0.0052	0.0031
27	-0.00000004	-0.0001	-0.0021	0.0003
28	0.00000005	0.0002	0.0028	0.0005
29	-0.00000006	-0.0002	-0.0038	0.0022
30	-0.00000010	-0.0003	-0.0056	-0.0020
31	0.00000009	0.0003	0.0053	-0.0023
32	0.00000008	0.0003	0.0046	0.0019
33	-0.00000006	-0.0002	-0.0037	0.0016
34	-0.00000005	-0.0002	-0.0030	-0.0010
35	0.00000002	0.0001	0.0015	-0.0010

DAYS 1 THRU 95 JD 2443509.5 TO 2443604.5 DATES JAN 1 THRU APR 5

A = 47.50000000 B = -1.02105263

CHEBYSHEV COEFFICIENTS

	R A	DEC	DISTANCE	S D	EPHEM TR
	H	O	AU	"	H
0	43.8895889	-20.411748	1.98032230	32.35908	24.2752379
1	3.1045216	15.122394	0.00896022	-0.14613	-0.0202270
2	-0.0926256	1.800386	0.00188097	-0.03013	-0.0919054
3	0.0121068	-0.488968	-0.00027369	0.00477	0.0124798
4	0.0042544	-0.001180	-0.00002072	0.00033	0.0041732
5	-0.0007390	0.005207	0.00001654	-0.00028	-0.0007367
6	0.0000030	-0.001227	-0.00000089	0.00003	0.0000061
7	0.0000400	0.000255	0.00001125	-0.00019	0.0000443
8	0.0000648	0.000258	-0.00000884	0.00014	0.0000603
9	-0.0000337	-0.000160	-0.00001630	0.00024	-0.0000391
10	-0.0000447	-0.000174	0.00000594	-0.00009	-0.0000418
11	0.0000134	0.000047	0.00000684	-0.00009	0.0000166
12	0.0000138	0.000063	-0.00000177	0.00003	0.0000128
13	-0.0000036	-0.000017	-0.00000197	0.00003	-0.0000045
14	-0.0000041	-0.000016	0.00000043	-0.00002	-0.0000039
15	0.0000024	0.000006	0.00000046	-0.00001	0.0000016
16	0.0000001	0.0	-0.00000011	0.0	0.0
17	-0.0000001	0.000007	0.00000022	-0.00001	-0.0000001
18	0.0000020	0.0	-0.00000007	0.00001	0.0000012
19	-0.0000020	-0.000009	-0.00000039	0.00001	-0.0000007
20	-0.0000017	-0.000003	0.00000010	0.00001	-0.0000014
21	0.0000013	0.000005	0.00000025	-0.00001	0.0000008
22	0.0000008	0.000002	-0.00000003	-0.00001	0.0000007
23	-0.0000007	-0.000004	-0.00000009	0.00002	-0.0000003

DAYS 91 THRU 185 JD 2443599.5 TO 2443694.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.91578947

CHEBYSHEV COEFFICIENTS

	R A	DEC	DISTANCE	S D	EPHEM TR
	H	O	AU	"	H
0	7.4616235	33.035860	2.01950829	31.73115	24.0190620
1	3.1298562	9.549755	0.00895039	-0.14087	0.0110102
2	0.0656227	-2.976516	-0.00179709	0.02883	0.0651947
3	-0.0066525	-0.293889	-0.00023926	0.00352	-0.0070404
4	-0.0049863	0.036143	0.00003423	-0.00054	-0.0049724
5	0.0001242	0.006054	0.00001216	-0.00017	0.0001467
6	0.0001683	0.000068	-0.00000213	0.00003	0.0001697
7	0.0000522	-0.000211	0.00000851	-0.00013	0.0000550
8	0.0000496	0.000178	-0.00001355	0.00022	0.0000427
9	-0.0000517	-0.000080	-0.00001325	0.00022	-0.0000582
10	-0.0000395	-0.000082	0.00000914	-0.00016	-0.0000362
11	0.0000221	0.000070	0.00000608	-0.00008	0.0000239
12	0.0000125	0.000016	-0.00000285	0.00004	0.0000121
13	-0.0000055	-0.000020	-0.00000124	0.00002	-0.0000060
14	-0.0000021	0.000002	0.00000080	-0.00001	-0.0000015
15	0.0000007	0.000002	0.00000010	0.0	0.0000016
16	0.0000009	-0.000001	-0.00000012	0.00001	0.0000006
17	0.0000001	-0.000001	-0.00000028	0.0	-0.0000004
18	-0.0000006	-0.000006	-0.00000021	0.0	-0.0000013
19	0.0000004	0.000003	0.00000035	-0.00002	-0.0000007
20	0.0000005	0.000005	0.00000023	0.00001	0.0000013
21	-0.0000005	-0.000002	-0.00000020	0.00002	0.0000002
22	-0.0000002	-0.000003	-0.00000010	0.0	-0.0000003
23	0.0000003	0.000002	0.00000007	0.0	-0.0000001

DAYS 182 THRU 276 JD 2443690.5 TO 2443785.5 DATES JULY 1 THRU OCT 3

A = 47.50000000 B = -4.83157895

CHEBYSHEV COEFFICIENTS

	R A	DEC	DISTANCE	S D	EPHEM TR
	H	O	AU	'	H
0	19.4002021	22.935748	2.02079423	31.71080	23.9965533
1	2.9887720	-14.010239	-0.00836683	0.13154	-0.1348150
2	-0.0649546	-1.968420	-0.00190349	0.03037	-0.0642675
3	0.0109403	0.377967	0.00022749	-0.00334	0.0112542
4	0.0037657	0.010847	0.00003873	-0.00062	0.0037194
5	-0.0004006	-0.002783	0.00000233	-0.00005	-0.0004034
6	-0.0000251	0.000690	-0.00000255	0.00003	-0.0000222
7	0.0000574	-0.000232	0.00000286	-0.00003	0.0000585
8	0.0000160	-0.000006	-0.00001836	0.00029	0.0000097
9	-0.0000684	0.000245	-0.00000449	0.00008	-0.0000701
10	-0.0000124	0.000052	0.00001332	-0.00023	-0.0000062
11	0.0000310	-0.000104	0.00000194	-0.00003	0.0000320
12	0.0000039	-0.000028	-0.00000420	0.00007	0.0000015
13	-0.0000065	0.000019	-0.00000042	0.0	-0.0000063
14	0.0000005	0.000003	0.00000045	0.00001	-0.0000002
15	0.0000002	-0.000002	0.00000009	-0.00001	0.0000004
16	-0.0000002	0.000001	-0.00000019	0.0	0.0
17	-0.0000012	0.000009	-0.00000010	0.00001	-0.0000013
18	-0.0000014	0.000007	0.00000047	0.00001	0.0000001
19	0.0000014	-0.000012	0.00000008	0.0	0.0000016
20	0.0000017	-0.000006	-0.00000038	0.00001	-0.0000001
21	-0.0000007	0.000009	-0.00000001	0.0	-0.0000012
22	-0.0000010	0.000004	0.00000018	0.0	0.0000002
23	0.0	-0.000003	-0.00000001	-0.00001	0.0000005

DAYS 274 THRU 368 JD 2443782.5 TO 2443877.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.76842105

CHEBYSHEV COEFFICIENTS

	R A	DEC	DISTANCE	S D	EPHEM TR
	H	O	AU	'	H
0	31.2084693	-31.774703	1.98095544	32.34881	23.7186764
1	3.2515418	-10.321917	-0.00924620	0.15071	0.1340667
2	0.1022721	3.041691	0.00181921	-0.02905	0.1017471
3	-0.0082774	0.412674	0.00028456	-0.00492	-0.0087923
4	-0.0066161	-0.035608	-0.00001366	0.00022	-0.0066293
5	-0.0001118	-0.011013	-0.00000992	0.00016	-0.0000908
6	0.0002257	-0.000556	-0.00000193	0.00003	0.0002291
7	0.0000818	0.000085	-0.00000574	0.00010	0.0000786
8	-0.0000412	0.000052	-0.00001744	0.00030	-0.0000495
9	-0.0000695	0.000184	0.00000839	-0.00016	-0.0000647
10	0.0000233	-0.000078	0.00001147	-0.00019	0.0000283
11	0.0000269	-0.000067	-0.00000377	0.00004	0.0000267
12	-0.0000078	0.000035	-0.00000362	0.00005	-0.0000088
13	-0.0000084	0.000018	0.00000091	-0.00002	-0.0000078
14	0.0000004	-0.000001	0.00000101	-0.00002	0.0000016
15	0.0000032	-0.000006	-0.00000005	-0.00001	0.0000023
16	0.0000003	0.000004	-0.00000008	0.0	0.0000004
17	0.0000012	0.0	0.00000001	0.0	0.0000011
18	0.0000004	-0.000011	-0.00000034	0.0	0.0
19	-0.0000031	0.000006	-0.00000007	0.00001	-0.0000015
20	-0.0000006	0.000010	0.00000030	0.0	0.0000002
21	0.0000020	-0.000007	0.00000004	-0.00001	0.0000011
22	0.0000004	-0.000005	-0.00000017	0.0	-0.0000002
23	-0.0000011	0.000003	0.0	0.00001	-0.0000005

DAYS 1 THRU 32 JD 2443509.5 TO 2443541.5 DATES JAN 1 THRU FEB 1

A = 16.00000000 B = -1.06250000

CHEBYSHEV COEFFICIENTS

	R A	DEC	H P	X	Y	Z
	H	O	•			
0	51.60673997	-5.1089651	114.8156979	-44.0826759	-11.2354283	-4.3331104
1	14.03288316	1.7823426	-0.7018198	-4.2358598	5.2911430	1.8528126
2	-0.44191556	-8.1049926	0.7771724	-46.2838904	-23.8090561	-8.5815876
3	0.10025645	-12.8887133	2.6059660	23.5939362	-40.7684238	-13.2639775
4	0.17082232	4.7349885	-0.8705798	24.1839214	13.3549661	4.7862038
5	-0.10611126	2.4643574	-0.4603912	-6.6363012	8.8204111	2.8253102
6	0.04959533	-1.1694206	0.4836206	-2.4079463	-2.6744623	-0.9245403
7	0.04827931	0.2345860	-0.0703782	1.1321237	-0.1349777	-0.0254557
8	-0.03674343	0.1272112	-0.1223582	-0.2983517	0.3902050	0.1254534
9	-0.00296345	-0.1879277	0.0602316	-0.1080507	-0.2340656	-0.0797364
10	0.00902969	0.0803271	0.0013708	0.1364905	0.0010546	0.0024313
11	-0.00408982	0.0339029	-0.0176963	-0.0280643	0.0580976	0.0189320
12	0.00046949	-0.0448391	0.0090868	-0.0216405	-0.0233679	-0.0081164
13	0.00125550	0.0088901	0.0012211	0.0152121	-0.0043860	-0.0012286
14	-0.00126593	0.0080230	-0.0032986	-0.0012674	0.0071865	0.0023746
15	0.00020291	-0.0069080	0.0011620	-0.0030267	-0.0021592	-0.0007666
16	0.00040012	0.0018225	0.0004216	0.0017543	-0.0008014	-0.0002395
17	-0.00026892	0.0012441	-0.0005397	-0.0000169	0.0009602	0.0003200
18	0.00001824	-0.0015052	0.0001367	-0.0004696	-0.0002211	-0.0000813
19	0.00007421	0.0004339	0.0000955	0.0002144	-0.0001593	-0.0000499
20	-0.00005736	0.0003027	-0.0000880	0.0000294	0.0001302	0.0000441
21	0.00001136	-0.0003150	0.0000136	-0.0000709	-0.0000164	-0.0000068
22	0.00001682	0.0000778	0.0000203	0.0000247	-0.0000279	-0.0000091
23	-0.00001540	0.0000587	-0.0000138	0.0000084	0.0000176	0.0000060
24	0.00000253	-0.0000639	0.0000006	-0.0000109	-0.0000002	-0.0000002
25	0.00000424	0.0000196	0.0000040	0.0000024	-0.0000050	-0.0000016
26	-0.00000346	0.0000115	-0.0000021	0.0000020	0.0000021	0.0000008
27	0.00000065	-0.0000145	-0.0000003	-0.0000014	0.0000004	0.0000001
28	0.00000089	0.0000044	0.0000007	0.0000002	-0.0000006	-0.0000002
29	-0.00000087	0.0000024	-0.0000005	0.0000003	0.0000003	0.0000001
30	0.00000020	-0.0000033	0.0	-0.0000003	0.0	0.0
31	0.00000024	0.0000012	0.0000002	0.0	-0.0000002	0.0
32	-0.00000022	0.0000007	0.0	0.0000002	0.0000001	0.0
33	0.00000007	-0.0000008	-0.0000001	-0.0000001	0.0000001	-0.0000001
34	0.00000004	0.0000002	0.0000002	-0.0000002	-0.0000002	-0.0000001
35	-0.00000006	0.0000004	-0.0000001	0.0000001	-0.0000001	0.0000001
36	0.00000002	-0.0000002	0.0000001	0.0	0.0000001	0.0
37	0.00000001	0.0000001	0.0000001	-0.0000001	0.0	-0.0000001

CHEBYSHEV APPROXIMATION OF LUNAR COORDINATES FOR YEAR 1978

DAYS 32 THRU 63 JD 2443540.5 TO 2443572.5 DATES FEB 1 THRU MAR 4

A = 16.00000000 B = -3.00000000

CHEBYSHEV COEFFICIENTS

	R A	DEC	H P	X	Y	Z
	H	O	"			
0	56.27531635	-12.8690752	116.1146347	-13.0412184	-36.5183468	-12.2075362
1	14.04882989	0.2059674	-0.4097016	-6.8334192	0.6357679	0.2284548
2	-0.20844662	-15.9118195	2.1461427	-11.6552963	-49.1068729	-16.3773086
3	0.33179065	-2.7344051	1.1070218	48.3332301	-9.9206100	-2.7769944
4	0.05476678	8.2766887	-1.4187710	5.6626900	25.9622131	8.6317570
5	-0.02927490	0.1399453	0.0865721	-10.7428046	1.6227659	0.4106114
6	0.04250389	-0.6039325	0.3263043	-0.0861189	-2.8415174	-0.9361537
7	-0.03649387	0.2138314	-0.1621411	0.3703575	0.2601396	0.0919259
8	-0.01370631	-0.1855424	-0.0209379	-0.1880521	-0.1813874	-0.0624496
9	0.01021970	0.0150527	0.0304331	0.1871319	-0.0640863	-0.0192045
10	-0.00119756	0.0338937	-0.0148992	0.0031027	0.0955628	0.0316413
11	0.00010447	-0.0333124	0.0037697	-0.0408495	-0.0135239	-0.0049431
12	0.00047329	0.0072354	0.0043346	0.0124056	-0.0115342	-0.0036691
13	-0.00038754	0.0052622	-0.0029830	0.0012920	0.0062901	0.0020978
14	0.00034250	-0.0032682	0.0001682	-0.0024577	-0.0013720	-0.0004832
15	-0.00005314	0.0012415	0.0005212	0.0014138	-0.0004334	-0.0001274
16	-0.00012546	-0.0000062	-0.0003261	-0.0002117	0.0007612	0.0002492
17	0.00005808	-0.0003231	0.0000718	-0.0003229	-0.0002678	-0.0000923
18	-0.00000699	0.0002160	0.0000552	0.0001865	-0.0000743	-0.0000221
19	-0.00000471	-0.0000959	-0.0000535	-0.0000117	0.0000842	0.0000277
20	0.00000640	-0.0000169	0.0000113	-0.0000296	-0.0000258	-0.0000089
21	-0.00000456	0.0000379	0.0000079	0.0000193	-0.0000032	-0.0000009
22	0.00000200	-0.0000151	-0.0000066	-0.0000044	0.0000088	0.0000027
23	0.00000076	0.0000020	0.0000019	-0.0000028	-0.0000043	-0.0000016
24	-0.00000122	0.0000018	0.0000009	0.0000029	0.0	0.0000001
25	0.00000040	-0.0000020	-0.0000011	-0.0000008	0.0000013	0.0000005
26	0.00000003	0.0000010	0.0000005	-0.0000004	-0.0000006	-0.0000002
27	-0.00000010	-0.0000004	0.0000001	0.0000004	0.0	0.0
28	0.00000007	-0.0000001	-0.0000002	-0.0000001	0.0000002	0.0
29	-0.00000003	0.0000001	0.0000001	-0.0000001	0.0	0.0
30	0.00000002	-0.0000001	0.0000001	-0.0000001	0.0000001	0.0
31	0.00000001	-0.0000001	0.0	0.0	-0.0000001	0.0
32	0.00000001	0.0000001	0.0	0.0	0.0	0.0
33	-0.00000001	-0.0000001	-0.0000001	0.0000001	0.0	0.0
34	-0.00000001	0.0000001	0.0	0.0	0.0	0.0
35	0.00000001	0.0	-0.0000001	0.0	0.0000001	0.0
36	-0.00000001	0.0	0.0	0.0	-0.0000001	0.0000001
37	0.00000002	0.0	0.0	0.0	0.0000001	0.0

DAYS 60 THRU 91 JD 2443568.5 TO 2443600.5 DATES MAR 1 THRU APR 1

A = 16.00000000 B = -4.75000000

CHEBYSHEV COEFFICIENTS

	R A	DEC	H P	X	Y	Z
	H	O	•			
0	59.56895278	-13.2930496	115.9800399	-4.3631708	-38.7126742	-12.7810749
1	14.07169784	-0.0131193	-0.1275365	-6.5190571	0.1576875	0.0158945
2	-0.08455530	-16.0707342	1.9217386	-2.9594441	-50.3279699	-16.5746540
3	0.31790254	-0.3421681	0.5282666	49.2519136	-2.7193307	-0.4316063
4	0.03651995	8.3914919	-1.4053855	1.4012161	26.6161730	8.7595061
5	-0.02981112	-0.0998346	-0.0657647	-10.9469782	0.3494873	0.0078535
6	0.00285585	-0.5977659	0.3806857	0.0932446	-2.8906089	-0.9473489
7	-0.03512191	0.1084234	-0.0317586	0.3580760	0.1512025	0.0537324
8	-0.00151630	-0.1894028	-0.0482737	-0.1031881	-0.1957986	-0.0655791
9	0.00870266	-0.0137751	0.0131095	0.1959749	-0.0428442	-0.0122456
10	-0.00074334	0.0329424	-0.0089515	0.0115443	0.0995985	0.0328468
11	0.00042430	-0.0054931	-0.0016561	-0.0432706	-0.0006692	-0.0006406
12	0.00028521	0.0047132	0.0052382	0.0033043	-0.0131536	-0.0042882
13	-0.00019812	0.0014328	-0.0004482	0.0025367	0.0023689	0.0008048
14	0.00002407	-0.0017576	-0.0008527	-0.0013081	-0.0006617	-0.0002306
15	-0.00010953	0.0001954	0.0002609	0.0010727	-0.0004922	-0.0001516
16	-0.00001486	0.0000541	-0.0000731	0.0001287	0.0006812	0.0002251
17	0.00003666	-0.0000977	-0.0000458	-0.0003570	-0.0000095	-0.0000066
18	-0.00000506	-0.0000024	0.0000688	0.0000400	-0.0001315	-0.0000426
19	0.00000154	0.0000005	-0.0000051	0.0000367	0.0000298	0.0000102
20	0.00000230	0.0000164	-0.0000145	-0.0000175	0.0000002	-0.0000002
21	-0.00000124	0.0000012	0.0000047	0.0000078	-0.0000071	-0.0000023
22	0.00000017	-0.0000016	-0.0000001	0.0000023	0.0000060	0.0000020
23	-0.00000046	0.0000014	-0.0000008	-0.0000035	0.0000002	0.0
24	-0.00000012	-0.0000013	0.0000009	0.0000006	-0.0000013	-0.0000005
25	0.00000021	-0.0000001	-0.0000001	0.0000004	0.0000005	0.0000001
26	-0.00000005	0.0000002	-0.0000003	-0.0000003	-0.0000001	0.0
27	0.00000001	-0.0000003	0.0000001	0.0000001	-0.0000001	0.0
28	-0.00000001	0.0000003	0.0	0.0000002	0.0000001	0.0000001
29	0.0	0.0000001	0.0	0.0	0.0000001	0.0000001
30	0.00000001	-0.0000001	0.0	-0.0000001	0.0	-0.0000001
31	-0.00000003	0.0	0.0000001	0.0	-0.0000001	0.0
32	-0.00000001	0.0	0.0	0.0	0.0	0.0
33	-0.00000001	0.0000002	0.0	0.0	0.0	0.0
34	0.00000001	-0.0000001	0.0	-0.0000001	0.0	0.0
35	0.00000001	-0.0000001	0.0	0.0	0.0000001	0.0
36	-0.00000002	0.0	0.0	0.0000001	0.0	0.0000001
37	0.0	0.0	0.0000001	0.0	0.0	0.0

CHEBYSHEV APPROXIMATION OF LUNAR COORDINATES FOR YEAR 1978

DAYS 91 THRU 122 JD 2443599.5 TO 2443631.5 DATES APR 1 THRU MAY 2

A = 16.00000000 B = -6.68750000

CHEBYSHEV COEFFICIENTS

	R A	DEC	H P	X	Y	Z
	H	0	'			
0	66.34407115	-8.0794457	115.5677113	34.4948955	-24.2487552	-7.6851659
1	14.05350654	-1.4111875	0.2063989	-4.6903231	-4.3918384	-1.5318185
2	0.24428119	-10.5977730	1.4666023	37.7524397	-35.1227525	-11.2162999
3	0.20113874	11.2830305	-1.4405886	34.0449374	33.7552003	11.4118993
4	-0.10475062	5.7425646	-1.1186884	-19.8583256	18.8709291	6.0370724
5	-0.08525151	-2.1103037	0.4646945	-8.2035094	-7.1789080	-2.4265372
6	-0.04730393	-0.8401880	0.3427488	1.8329174	-2.6341476	-0.8507356
7	0.02182403	-0.2409083	-0.0617057	0.7356935	-0.0031305	0.0039679
8	0.02772925	-0.0017877	-0.0689986	0.3085377	0.1351613	0.0471072
9	0.00080669	0.1359847	-0.0147685	0.0011004	0.2126345	0.0700531
10	-0.00395856	0.0574417	0.0045397	-0.1128158	0.0225769	0.0064714
11	-0.00220654	-0.0133405	0.0103649	-0.0193513	-0.0435778	-0.0144965
12	-0.00098350	-0.0209135	0.0023510	0.0147938	-0.0115573	-0.0036814
13	0.00020174	-0.0058938	-0.0024082	0.0066130	0.0027312	0.0009527
14	0.00060582	0.0019125	-0.0011287	0.0006541	0.0030523	0.0010114
15	0.00026667	0.0024890	0.0000858	-0.0013676	0.0011030	0.0003512
16	-0.00007957	0.0010510	0.0002822	-0.0008427	-0.0004503	-0.0001559
17	-0.00010999	-0.0001063	0.0001328	0.0001017	-0.0004454	-0.0001456
18	-0.00003789	-0.0004034	-0.0000318	0.0002175	-0.0000236	-0.0000057
19	0.00000409	-0.0002088	-0.0000516	0.0000476	0.0000798	0.0000267
20	0.00001696	0.0000085	-0.0000084	-0.0000241	0.0000359	0.0000115
21	0.00001115	0.0000650	0.0000091	-0.0000226	-0.0000017	-0.0000007
22	0.00000041	0.0000338	0.0000057	-0.0000040	-0.0000107	-0.0000037
23	-0.00000384	0.0000032	0.0000003	0.0000047	-0.0000039	-0.0000013
24	-0.00000229	-0.0000083	-0.0000015	0.0000027	0.0000014	0.0000005
25	-0.00000013	-0.0000071	-0.0000006	-0.0000001	0.0000014	0.0000005
26	0.00000063	-0.0000017	0.0000003	-0.0000006	0.0000003	0.0000001
27	0.00000045	0.0000015	0.0000003	-0.0000003	-0.0000002	-0.0000002
28	0.00000007	0.0000013	0.0	0.0000001	-0.0000001	0.0
29	-0.00000011	0.0000006	0.0	0.0000001	0.0000001	0.0
30	-0.00000013	-0.0000002	0.0000001	0.0000001	0.0	0.0
31	-0.00000003	-0.0000003	0.0	0.0	0.0000001	-0.0000001
32	0.00000001	-0.0000002	0.0	0.0	0.0000001	0.0
33	0.00000002	-0.0000001	-0.0000001	0.0	0.0	0.0
34	0.00000001	0.0000003	0.0	0.0	-0.0000001	0.0
35	-0.00000001	0.0000001	0.0	0.0	0.0	-0.0000001
36	0.0	0.0000002	0.0000001	-0.0000001	0.0000001	0.0
37	-0.00000002	0.0	-0.0000001	0.0000001	0.0000001	0.0000001

DAYS 121 THRU 152 JD 2443629.5 TO 2443661.5 DATES MAY 1 THRU JUNE 1

A = 16.00000000 B = -8.56250000

CHEBYSHEV COEFFICIENTS

	R A	DEC	H P	X	Y	Z
	H	O	'			
0	71.13902058	0.5991782	114.4695295	47.2230999	2.6993993	1.2202946
1	14.05989143	-2.1447850	0.4677978	-1.4155330	-6.2567804	-2.1757997
2	0.34823514	-1.6256864	0.2784077	51.6667755	-7.5813574	-2.1317513
3	0.01660414	14.7633659	-2.3994145	6.7788399	46.0400937	15.2936855
4	-0.18954080	1.2677957	-0.4942180	-27.6816549	4.6161924	1.3522026
5	-0.10531101	-3.4112684	0.7671189	-2.7879875	-10.7458948	-3.5619452
6	0.02607684	-0.8209161	0.3252007	3.5323104	-1.6624530	-0.5301242
7	0.07130322	0.1202113	-0.1338398	1.0207357	0.7070248	0.2383221
8	0.00811420	0.3195098	-0.1209301	0.0002668	0.5258329	0.1742929
9	-0.01847583	0.1606150	-0.0059827	-0.2646243	0.1172995	0.0373222
10	-0.00806271	-0.0550777	0.0283094	-0.0995392	-0.1038921	-0.0349827
11	0.00039126	-0.0811389	0.0144299	0.0368881	-0.0577045	-0.0188796
12	0.00294884	-0.0106095	-0.0031071	0.0323619	0.0071735	0.0025608
13	0.00186259	0.0203715	-0.0055916	0.0018956	0.0147910	0.0049075
14	-0.00030742	0.0116363	-0.0009990	-0.0066922	0.0034615	0.0011072
15	-0.00092385	-0.0005088	0.0012265	-0.0029332	-0.0023237	-0.0007869
16	-0.00027576	-0.0042586	0.0007346	0.0006395	-0.0017591	-0.0005782
17	0.00019709	-0.0020644	-0.0000750	0.0010060	-0.0000161	0.0000007
18	0.00018761	0.0005752	-0.0002472	0.0001804	0.0004578	0.0001522
19	0.00003138	0.0010251	-0.0000710	-0.0001998	0.0001622	0.0000524
20	-0.00005512	0.0002680	0.0000473	-0.0001174	-0.0000623	-0.0000212
21	-0.00004375	-0.0002282	0.0000386	0.0000105	-0.0000655	-0.0000216
22	-0.00000015	-0.0002039	0.0000005	0.0000357	-0.0000071	-0.0000022
23	0.00001740	-0.0000229	-0.0000115	0.0000101	0.0000157	0.0000053
24	0.00000860	0.0000630	-0.0000044	-0.0000065	0.0000075	0.0000024
25	-0.00000227	0.0000414	0.0000018	-0.0000050	-0.0000017	-0.0000006
26	-0.00000446	-0.0000029	0.0000020	0.0	-0.0000027	-0.0000009
27	-0.00000149	-0.0000171	0.0000002	0.0000014	-0.0000004	-0.0000001
28	0.00000097	-0.0000073	-0.0000004	0.0000005	0.0000005	0.0000001
29	0.00000114	0.0000025	-0.0000003	-0.0000001	0.0000003	0.0000002
30	0.00000019	0.0000039	0.0	-0.0000002	0.0	0.0
31	-0.00000034	0.0000011	0.0000001	0.0	0.0	-0.0000001
32	-0.00000026	-0.0000008	0.0000001	0.0000001	0.0	0.0
33	0.0	-0.0000007	0.0	-0.0000001	0.0	0.0
34	0.00000010	0.0	-0.0000002	0.0	0.0	0.0
35	0.00000005	0.0000004	0.0000001	0.0	-0.0000001	-0.0000001
36	0.00000001	0.0	0.0	0.0	0.0000001	-0.0000001
37	-0.00000003	0.0	0.0000001	0.0000001	0.0	0.0000001

CHEBYSHEV APPROXIMATION OF LUNAR COORDINATES FOR YEAR 1978

DAYS 152 THRU 183 JD 2443660.5 TO 2443692.5 DATES JUNE 1 THRU JULY 2

A = 16.00000000 B = -10.50000000

CHEBYSHEV COEFFICIENTS

	R A	DEC	H P	X	Y	Z
	H	O	•			
0	29.54396332	11.8009893	112.7553120	34.1422977	39.5107454	13.2487825
1	14.12201311	-1.8557494	0.5182826	4.2562009	-5.3368508	-1.8608030
2	0.28505415	10.3024385	-1.6101760	39.4289790	31.1310602	10.5128952
3	-0.18376195	10.8673635	-2.3192817	-31.6244003	35.0278151	11.5729083
4	-0.21352658	-5.4286411	0.7093663	-21.9797225	-16.6724176	-5.5793401
5	0.02714347	-3.3126571	0.9601479	7.1508297	-9.6435732	-3.1769588
6	0.12676395	0.5484441	-0.0184464	4.2992185	1.9480451	0.6513491
7	0.01204269	0.8245333	-0.3196739	-0.3113674	1.7195281	0.5689525
8	-0.04912667	0.1724249	-0.0625841	-0.7962168	0.1232037	0.0397914
9	-0.01247933	-0.2404960	0.0814308	-0.1688324	-0.3359987	-0.1118108
10	0.01196341	-0.1412135	0.0386094	0.1530961	-0.1184921	-0.0390704
11	0.00775568	0.0586548	-0.0141013	0.0785354	0.0585373	0.0195758
12	-0.00156245	0.0656400	-0.0159584	-0.0218353	0.0434897	0.0144000
13	-0.00375692	-0.0046192	0.0002564	-0.0252513	-0.0053325	-0.0018159
14	-0.00049315	-0.0241141	0.0051587	-0.0001576	-0.0126326	-0.0041949
15	0.00143768	-0.0054657	0.0012364	0.0066906	-0.0016146	-0.0005238
16	0.00058509	0.0072991	-0.0013218	0.0016887	0.0030398	0.0010122
17	-0.00040720	0.0043205	-0.0007355	-0.0014364	0.0012033	0.0003969
18	-0.00035260	-0.0015778	0.0002302	-0.0008326	-0.0005573	-0.0001862
19	0.00005554	-0.0021362	0.0002964	0.0002026	-0.0004810	-0.0001594
20	0.00016376	0.0000061	0.0000038	0.0002894	0.0000410	0.0000139
21	0.00002756	0.0008314	-0.0000949	0.0000129	0.0001495	0.0000498
22	-0.00006105	0.0002410	-0.0000261	-0.0000813	0.0000249	0.0000082
23	-0.00002995	-0.0002564	0.0000241	-0.0000236	-0.0000378	-0.0000125
24	0.00001679	-0.0001731	0.0000147	0.0000182	-0.0000165	-0.0000055
25	0.00001771	0.0000514	-0.0000040	0.0000113	0.0000070	0.0000022
26	-0.00000167	0.0000849	-0.0000057	-0.0000025	0.0000065	0.0000022
27	-0.00000807	0.0000046	-0.0000003	-0.0000039	-0.0000004	-0.0000001
28	-0.00000176	-0.0000332	0.0000018	-0.0000002	-0.0000020	-0.0000006
29	0.00000292	-0.0000118	0.0000005	0.0000012	-0.0000004	-0.0000001
30	0.00000166	0.0000103	-0.0000004	0.0000003	0.0000006	0.0000003
31	-0.00000075	0.0000081	-0.0000003	-0.0000003	0.0000002	0.0000001
32	-0.00000095	-0.0000019	0.0000001	-0.0000002	-0.0000002	0.0
33	0.00000001	-0.0000036	0.0000001	0.0000001	-0.0000001	0.0
34	0.00000042	-0.0000003	0.0	0.0000001	0.0	0.0
35	0.00000010	0.0000014	0.0	0.0	0.0	0.0
36	-0.00000014	0.0000006	-0.0000001	0.0	0.0	0.0
37	-0.00000009	-0.0000002	0.0	0.0	0.0	0.0000001

CHEBYSHEV APPROXIMATION OF LUNAR COORDINATES FOR YEAR 1978

DAYS 182 THRU 213 JD 2443690.5 TO 2443722.5 DATES JULY 1 THRU AUG 1

A = 16.00000000 B = -12.37500000

CHEBYSHEV COEFFICIENTS

	R A	DEC	H P	X	Y	Z
	H	O	'			
0	34.19703353	15.8182341	111.9006182	7.8178215	53.4525678	17.7481941
1	14.15642133	-0.7434956	0.4384565	6.9482932	-2.0134664	-0.7684215
2	0.21153383	14.7978870	-2.5402029	13.2684777	46.6656510	15.5209780
3	-0.26695309	3.4737710	-1.5337624	-46.8471211	11.3357077	3.8604065
4	-0.15131283	-8.2565429	1.3515927	-7.7148848	-25.7378218	-8.5047213
5	0.12939970	-1.3902383	0.7684101	12.1279406	-3.7484117	-1.2605329
6	0.08404521	1.6299278	-0.2829129	2.0903957	4.4331087	1.4594941
7	-0.05842410	0.5900444	-0.3228416	-1.7228784	1.0719887	0.3580061
8	-0.03698362	-0.3266419	0.0394818	-0.6354244	-0.6112486	-0.2005832
9	0.01728071	-0.2714955	0.1084009	0.2438528	-0.3373376	-0.1122341
10	0.01438925	0.0785798	0.0059309	0.1961361	0.0842073	0.0274093
11	-0.00358979	0.1140869	-0.0322803	-0.0278473	0.1009341	0.0334888
12	-0.00594970	-0.0144094	-0.0079460	-0.0565251	-0.0050100	-0.0015249
13	0.00050212	-0.0433107	0.0088234	-0.0019934	-0.0279902	-0.0092647
14	0.00251207	-0.0010802	0.0042359	0.0150473	-0.0033164	-0.0011334
15	0.00010659	0.0156372	-0.0020807	0.0030903	0.0071379	0.0023569
16	-0.00101315	0.0028230	-0.0017701	-0.0036590	0.0021527	0.0007212
17	-0.00017674	-0.0055079	0.0003515	-0.0015139	-0.0016400	-0.0005400
18	0.00038890	-0.0018878	0.0006455	0.0007806	-0.0009076	-0.0003025
19	0.00012875	0.0018639	0.0000054	0.0005784	0.0003145	0.0001032
20	-0.00014346	0.0009948	-0.0002116	-0.0001261	0.0003223	0.0001072
21	-0.00007463	-0.0005891	-0.0000416	-0.0001932	-0.0000359	-0.0000116
22	0.00005009	-0.0004738	0.0000621	0.0000034	-0.0001021	-0.0000339
23	0.00003866	0.0001664	0.0000254	0.0000581	-0.0000073	-0.0000025
24	-0.00001588	0.0002123	-0.0000159	0.0000091	0.0000291	0.0000097
25	-0.00001871	-0.0000371	-0.0000116	-0.0000156	0.0000073	0.0000024
26	0.00000414	-0.0000910	0.0000031	-0.0000056	-0.0000073	-0.0000025
27	0.00000863	0.0000024	0.0000044	0.0000038	-0.0000036	-0.0000012
28	-0.00000056	0.0000376	-0.0000002	0.0000023	0.0000016	0.0000006
29	-0.00000379	0.0000042	-0.0000016	-0.0000008	0.0000014	0.0000004
30	-0.00000030	-0.0000149	-0.0000002	-0.0000007	-0.0000002	-0.0000002
31	0.00000161	-0.0000037	0.0000005	0.0	-0.0000004	-0.0000002
32	0.00000036	0.0000057	0.0000002	0.0000002	0.0000001	0.0000001
33	-0.00000065	0.0000023	0.0	-0.0000001	0.0000002	0.0
34	-0.00000026	-0.0000019	-0.0000001	0.0	-0.0000001	-0.0000001
35	0.00000024	-0.0000012	0.0	0.0	0.0	0.0
36	0.00000015	0.0000004	-0.0000001	0.0	-0.0000001	0.0
37	-0.00000007	0.0000008	0.0000001	0.0	0.0000001	0.0

CHEBYSHEV APPROXIMATION OF LUNAR COORDINATES FOR YEAR 1978

DAYS 213 THRU 244 JD 2443721.5 TO 2443753.5 DATES AUG 1 THRU SEPT 1

A = 16.00000000 B = -14.31250000

CHEBYSHEV COEFFICIENTS

	R A	DEC	H P	X	Y	Z
	H	0	•			
0	40.52062903	13.5098176	111.7106333	-31.0761595	46.0011197	15.3394688
1	14.15074726	1.2249492	0.1083985	6.2879506	3.8696644	1.2042211
2	0.03318958	12.6812617	-2.7483669	-27.4946597	40.3146080	13.4785920
3	-0.33606864	-7.8232127	0.2065078	-40.4205231	-25.4338311	-8.1747934
4	0.01017856	-7.1727878	1.6622575	15.3139570	-22.3807612	-7.4418836
5	0.13571115	2.2574610	0.1028716	10.7275570	6.7640432	2.1751875
6	-0.04656524	1.5849940	-0.5301219	-2.8710405	4.0985423	1.3607138
7	-0.05103928	-0.5142105	-0.0966010	-1.7423309	-1.1216792	-0.3606085
8	0.02673879	-0.4065533	0.1674488	0.5015810	-0.7215366	-0.2397840
9	0.01693941	0.1687437	0.0366665	0.3625655	0.2128686	0.0682388
10	-0.01013891	0.1286156	-0.0507538	-0.1008553	0.1735992	0.0576470
11	-0.00510806	-0.0647850	-0.0127921	-0.0946061	-0.0435346	-0.0138498
12	0.00393843	-0.0411235	0.0152769	0.0208585	-0.0469703	-0.0155691
13	0.00144715	0.0245999	0.0046945	0.0259881	0.0091438	0.0028779
14	-0.00165911	0.0127847	-0.0046134	-0.0044502	0.0130171	0.0043079
15	-0.00036551	-0.0092059	-0.0017270	-0.0072593	-0.0019590	-0.0006085
16	0.00069733	-0.0038239	0.0013954	0.0009394	-0.0036686	-0.0012121
17	0.00007080	0.0034813	0.0006230	0.0020651	0.0003988	0.0001214
18	-0.00028454	0.0010680	-0.0004221	-0.0001792	0.0010530	0.0003475
19	0.00000023	-0.0013294	-0.0002211	-0.0005974	-0.0000685	-0.0000199
20	0.00011346	-0.0002616	0.0001270	0.0000252	-0.0003065	-0.0001011
21	-0.00001175	0.0005072	0.0000777	0.0001747	0.0000060	0.0000013
22	-0.00004446	0.0000452	-0.0000379	0.0000008	0.0000899	0.0000295
23	0.00000951	-0.0001921	-0.0000271	-0.0000513	0.0000026	0.0000010
24	0.00001707	0.0000036	0.0000111	-0.0000028	-0.0000265	-0.0000087
25	-0.00000569	0.0000719	0.0000095	0.0000152	-0.0000022	-0.0000007
26	-0.00000640	-0.0000094	-0.0000032	0.0000016	0.0000078	0.0000025
27	0.00000303	-0.0000264	-0.0000033	-0.0000045	0.0000011	0.0000004
28	0.00000232	0.0000065	0.0000008	-0.0000007	-0.0000024	-0.0000008
29	-0.00000150	0.0000097	0.0000012	0.0000013	-0.0000005	-0.0000001
30	-0.00000080	-0.0000039	-0.0000003	0.0000004	0.0000006	0.0000003
31	0.00000071	-0.0000032	-0.0000002	-0.0000003	0.0000002	0.0
32	0.00000028	0.0000017	0.0000001	-0.0000002	-0.0000002	-0.0000001
33	-0.00000031	0.0000012	0.0000002	0.0000001	-0.0000001	0.0
34	-0.00000008	-0.0000007	0.0000001	0.0000001	0.0	0.0000001
35	0.00000013	-0.0000004	-0.0000001	0.0	0.0	0.0
36	0.0	0.0000004	-0.0000001	-0.0000001	0.0	0.0
37	-0.00000006	0.0000001	-0.0000001	-0.0000001	-0.0000001	0.0

DAYS 244 THRU 275 JD 2443752.5 TO 2443784.5 DATES SEPT 1 THRU OCT 2

A = 16.00000000 B = -16.25000000

CHEBYSHEV COEFFICIENTS

	R A	DEC	H P	X	Y	Z
	H	O	'			
0	46.76714597	3.9530020	112.7410458	-51.9623674	13.9849865	4.9106888
1	14.09498887	2.3088226	-0.1389609	1.0795612	7.1273992	2.3238654
2	-0.20541223	2.6024272	-1.5806444	-50.2815125	7.3569104	2.7292322
3	-0.25721925	-14.2506480	1.7003029	-7.4681323	-45.9290131	-15.0308090
4	0.13577429	-1.2289951	1.0596368	27.6896809	-3.6902123	-1.3798667
5	0.02561552	3.9391002	-0.4973387	1.1709483	11.8011791	3.8631024
6	-0.04815248	-0.1774272	-0.3739109	-4.7473648	-0.0698738	0.0057158
7	0.02895887	-0.7472502	0.1191811	0.3490587	-1.6967797	-0.5582371
8	0.01408941	0.1975870	0.1071174	0.7070886	0.2736052	0.0854842
9	-0.01530702	0.1520955	-0.0439253	-0.1725552	0.2905699	0.0963244
10	-0.00163158	-0.0802334	-0.0262024	-0.1395760	-0.0873710	-0.0278061
11	0.00512771	-0.0221147	0.0164231	0.0468985	-0.0617344	-0.0205352
12	-0.00081501	0.0267683	0.0061774	0.0303885	0.0230508	0.0073745
13	-0.00127222	-0.0010213	-0.0054324	-0.0128426	0.0134522	0.0044914
14	0.00067783	-0.0073565	-0.0013926	-0.0065954	-0.0066147	-0.0021291
15	0.00015173	0.0022931	0.0017058	0.0037954	-0.0028964	-0.0009732
16	-0.00030074	0.0014432	0.0002769	0.0014025	0.0019650	0.0006354
17	0.00006140	-0.0010474	-0.0005330	-0.0011186	0.0006018	0.0002039
18	0.00009214	-0.0000691	-0.0000397	-0.0002818	-0.0005715	-0.0001855
19	-0.00005484	0.0003094	0.0001650	0.0003221	-0.0001148	-0.0000394
20	-0.00001596	-0.0000999	-0.0000016	0.0000501	0.0001633	0.0000531
21	0.00002506	-0.0000507	-0.0000500	-0.0000917	0.0000182	0.0000065
22	-0.00000261	0.0000571	0.0000047	-0.0000065	-0.0000464	-0.0000151
23	-0.00000802	-0.0000082	0.0000147	0.0000261	-0.0000014	-0.0000007
24	0.00000377	-0.0000184	-0.0000027	-0.0000002	0.0000132	0.0000042
25	0.00000156	0.0000109	-0.0000042	-0.0000074	-0.0000006	-0.0000002
26	-0.00000195	0.0000032	0.0000011	0.0000006	-0.0000038	-0.0000012
27	0.00000012	-0.0000055	0.0000012	0.0000020	0.0000006	0.0000001
28	0.00000070	0.0000009	-0.0000004	-0.0000004	0.0000011	0.0000003
29	-0.00000031	0.0000018	-0.0000003	-0.0000006	-0.0000002	0.0
30	-0.00000015	-0.0000009	0.0000003	0.0000002	-0.0000002	-0.0000001
31	0.00000018	-0.0000003	0.0	0.0000002	0.0000001	0.0
32	0.00000003	0.0000004	-0.0000001	0.0	0.0000001	0.0
33	-0.00000005	-0.0000001	0.0000002	0.0	-0.0000001	0.0000001
34	0.00000001	-0.0000001	0.0	0.0	0.0	0.0
35	0.0	0.0	-0.0000001	0.0	-0.0000001	0.0
36	0.00000001	0.0	-0.0000001	-0.0000001	0.0	0.0
37	-0.00000001	0.0000001	0.0	0.0	0.0	0.0

CHEBYSHEV APPROXIMATION OF LUNAR COORDINATES FOR YEAR 1978

DAYS 274 THRU 305   JD 2443782.5 TO 2443814.5   DATES OCT 1 THRU NOV 1

A = 16.00000000   B = -18.12500000

CHEBYSHEV COEFFICIENTS

	R A	DEC	H P	X	Y	Z
	H	O	•			
0	51.36256130	-4.6196912	114.1045756	-47.0029580	-13.5791307	-4.1575850
1	14.04775894	2.0003730	-0.1402479	-3.4701478	6.5191531	2.1651160
2	-0.31664660	-6.6114305	-0.0149410	-46.0475311	-21.8260479	-6.9203384
3	-0.05751943	-13.4032958	2.1252686	21.8512682	-41.9936373	-13.9739714
4	0.15532460	3.7883325	0.2550629	24.6940037	12.1854075	3.8325245
5	-0.00946164	2.9901149	-0.5713899	-6.0774361	9.6858986	3.2264745
6	0.02382322	-1.0854390	-0.1970876	-3.1479333	-2.5352182	-0.8087577
7	0.01998479	-0.1588867	0.0958383	1.2022615	-0.6948846	-0.2360717
8	-0.02305299	0.2789699	0.0503714	0.0954280	0.5307911	0.1736148
9	-0.00344492	-0.0222002	-0.0315525	-0.2569497	-0.0134463	-0.0026920
10	0.00741538	-0.0344623	-0.0052068	0.0160528	-0.1079738	-0.0356075
11	-0.00114325	0.0050699	0.0115992	0.0485031	0.0082545	0.0023705
12	-0.00139158	-0.0030159	-0.0004211	-0.0047043	0.0194965	0.0064407
13	0.00056893	0.0013699	-0.0030964	-0.0089045	-0.0028318	-0.0008685
14	-0.00003976	0.0017069	0.0004615	0.0019539	-0.0038088	-0.0012652
15	-0.00004122	-0.0014303	0.0006842	0.0018546	0.0011783	0.0003747
16	0.00011210	-0.0000582	-0.0002112	-0.0007359	0.0008071	0.0002705
17	-0.00006181	0.0004597	-0.0001525	-0.0003769	-0.0003948	-0.0001271
18	-0.00002723	-0.0001645	0.0000769	0.0002250	-0.0001491	-0.0000508
19	0.00003540	-0.0000325	0.0000341	0.0000609	0.0001129	0.0000367
20	-0.00000269	0.0000677	-0.0000248	-0.0000618	0.0000199	0.0000071
21	-0.00000916	-0.0000352	-0.0000064	-0.0000060	-0.0000300	-0.0000099
22	0.00000375	-0.0000071	0.0000076	0.0000161	-0.0000006	-0.0000003
23	0.00000031	0.0000182	0.0000007	-0.0000007	0.0000076	0.0000027
24	-0.00000095	-0.0000050	-0.0000022	-0.0000040	-0.0000009	-0.0000002
25	0.00000070	-0.0000040	0.0	0.0000007	-0.0000018	-0.0000005
26	-0.00000013	0.0000030	0.0000007	0.0000010	0.0000005	0.0000001
27	-0.00000026	0.0	-0.0000001	-0.0000003	0.0000004	0.0000001
28	0.00000020	-0.0000008	-0.0000002	-0.0000001	-0.0000002	0.0
29	0.0	0.0000001	0.0000001	0.0000001	-0.0000001	0.0
30	-0.00000008	0.0000002	0.0000002	0.0	0.0000001	-0.0000001
31	0.0	0.0	-0.0000001	0.0	0.0	0.0
32	0.00000004	0.0000001	0.0000001	0.0	0.0	0.0
33	-0.00000002	-0.0000002	0.0	-0.0000001	0.0	0.0
34	0.0	0.0000003	0.0000001	0.0	0.0	0.0
35	0.0	0.0	0.0000001	0.0000001	0.0	0.0000001
36	0.00000001	-0.0000001	0.0000001	0.0	0.0000001	0.0
37	-0.00000002	-0.0000001	0.0	0.0000001	0.0	0.0

DAYS 305 THRU 336 JD 2443813.5 TO 2443845.5 DATES NOV 1 THRU DEC 2

A = 16.00000000 B = -20.06250000

CHEBYSHEV COEFFICIENTS

	R A	DEC	H P	X	Y	Z
	H	O	•			
0	57.93222316	-12.7187824	115.9674154	-15.8620481	-37.0305180	-12.1402563
1	14.02909024	0.4845394	0.0558440	-7.2807962	2.1089274	0.7256683
2	-0.20380638	-15.5292118	2.0613127	-13.0701260	-48.0238974	-15.8999820
3	0.27134181	-4.3968155	1.4657875	48.0851575	-12.3108621	-4.5279727
4	0.11991252	8.0133077	-0.8036643	6.7525392	25.4763816	8.3671826
5	0.02741163	0.5107403	-0.5081677	-10.7939722	2.1644290	0.8221452
6	0.01311580	-0.7538002	-0.0936182	-0.1541252	-3.0188094	-0.9908753
7	-0.05283896	0.3120929	0.0852515	0.6416980	0.3469870	0.1087470
8	-0.00806815	0.0053847	0.0404923	-0.3196035	0.0408808	0.0158161
9	0.01224817	-0.0718590	-0.0111190	0.0231308	-0.1649239	-0.0548552
10	-0.00223533	-0.0391405	0.0058960	0.0735570	0.0069276	0.0015624
11	-0.00129213	-0.0031247	0.0028765	0.0020510	0.0242909	0.0080095
12	0.00095535	0.0164180	-0.0035855	-0.0075663	0.0022025	0.0008089
13	0.00045666	-0.0011040	-0.0007279	-0.0006216	-0.0020283	-0.0006616
14	0.00010516	-0.0026602	0.0004774	0.0007765	0.0003427	0.0001074
15	-0.00025397	0.0018948	0.0000221	-0.0005296	0.0003905	0.0001337
16	-0.00004319	0.0003514	-0.0000381	-0.0002363	-0.0003548	-0.0001154
17	0.00008730	-0.0003635	0.0000376	0.0001942	-0.0001078	-0.0000371
18	-0.00002163	-0.0001390	0.0000208	0.0000416	0.0000792	0.0000258
19	-0.00002230	-0.0000087	-0.0000107	-0.0000313	0.0000074	0.0000024
20	0.00000795	0.0000639	-0.0000062	0.0000026	-0.0000108	-0.0000036
21	0.00000528	-0.0000104	0.0000021	0.0000045	0.0000036	0.0000013
22	0.00000012	-0.0000219	0.0000003	-0.0000024	0.0000019	0.0000006
23	-0.00000193	0.0000113	-0.0000007	-0.0000008	-0.0000011	-0.0000003
24	-0.00000008	0.0000052	0.0000002	0.0000005	-0.0000004	-0.0000001
25	0.00000092	-0.0000024	0.0000003	0.0000001	0.0	0.0000001
26	-0.00000021	-0.0000012	-0.0000001	-0.0000001	0.0	-0.0000001
27	-0.00000028	0.0000001	-0.0000001	0.0000002	0.0	-0.0000001
28	0.00000008	0.0000004	-0.0000001	0.0	0.0000001	0.0
29	0.00000006	-0.0000003	-0.0000001	-0.0000001	0.0	0.0
30	0.0	-0.0000003	0.0	0.0	0.0	0.0
31	-0.00000002	-0.0000002	0.0	0.0	-0.0000001	-0.0000001
32	0.00000002	0.0000001	0.0000001	0.0	0.0	0.0
33	0.00000001	0.0	-0.0000001	0.0	0.0	0.0
34	0.00000002	0.0000001	0.0	0.0	0.0000001	0.0
35	0.00000002	0.0000001	0.0	0.0	0.0	0.0
36	-0.00000001	0.0000002	-0.0000001	0.0	0.0000001	0.0
37	-0.00000001	0.0000001	-0.0000001	0.0000001	0.0	0.0

CHEBYSHEV APPROXIMATION OF LUNAR COORDINATES FOR YEAR 1978

DAYS 335 THRU 366 JD 2443843.5 TO 2443875.5 DATES DEC 1 THRU JAN 1

A = 16.00000000 B = -21.93750000

CHEBYSHEV COEFFICIENTS

	R A	DEC	H P	X	Y	Z
	H	O	'			
0	62.86248762	-12.4143317	116.8515237	13.0937999	-34.3656436	-11.6231572
1	13.99259809	-0.6700162	0.2462767	-7.4550694	-2.1044936	-0.6615280
2	0.02782904	-15.5240933	3.1026649	19.1162981	-46.4725478	-15.8562948
3	0.39468903	5.0008989	0.2535462	46.8886959	16.7424951	4.9395562
4	0.05486266	7.8162682	-1.2683750	-9.8339958	24.3616248	8.2317701
5	0.00529916	-0.8832694	-0.3564975	-9.9101028	-3.5734019	-1.0445926
6	-0.07142833	-0.3575617	-0.1124634	1.0341016	-2.3294339	-0.7806101
7	-0.05218701	0.0349267	0.1168220	0.1608839	0.1768898	0.0553697
8	0.01991955	-0.1629544	0.0705317	-0.0327950	-0.2098454	-0.0701709
9	0.00813934	-0.0916844	-0.0041391	0.1397518	-0.0272035	-0.0110457
10	-0.00105207	-0.0133173	0.0026134	0.0296109	0.0435707	0.0140053
11	0.00173694	0.0426610	-0.0030428	-0.0050660	0.0188071	0.0063430
12	0.00089775	0.0125216	-0.0040070	-0.0092895	0.0038163	0.0014151
13	-0.00042857	-0.0043134	-0.0004281	-0.0029851	-0.0027315	-0.0008615
14	-0.00076279	0.0011620	0.0002979	0.0002522	-0.0008748	-0.0002926
15	-0.00006950	-0.0002474	0.0003064	-0.0000768	-0.0003194	-0.0001059
16	0.00015082	-0.0014309	0.0001197	0.0002462	-0.0002618	-0.0000909
17	-0.00000937	-0.0005357	0.0000086	0.0001904	0.0000806	0.0000234
18	0.00000512	0.0002307	-0.0000079	-0.0000020	0.0000774	0.0000256
19	0.00003054	0.0002294	-0.0000198	-0.0000208	0.0000158	0.0000058
20	0.00000491	-0.0000027	-0.0000083	-0.0000111	0.0000009	0.0000007
21	-0.00001080	0.0000029	0.0000011	-0.0000040	-0.0000034	-0.0000012
22	-0.00000500	0.0000196	0.0000013	-0.0000003	-0.0000021	-0.0000008
23	0.00000146	-0.0000120	0.0000008	0.0000005	-0.0000010	-0.0000004
24	0.00000027	-0.0000139	0.0000003	0.0000009	-0.0000003	-0.0000002
25	-0.00000041	-0.0000009	0.0	0.0000004	0.0000004	0.0000002
26	0.00000047	0.0000029	-0.0000002	-0.0000001	0.0000003	0.0000001
27	0.00000038	0.0000006	-0.0000001	-0.0000001	-0.0000001	-0.0000001
28	-0.00000008	-0.0000001	0.0	0.0000001	-0.0000001	0.0
29	-0.00000012	0.0000004	0.0000001	0.0000001	0.0	-0.0000001
30	0.00000001	0.0	0.0	0.0000001	0.0000001	0.0
31	0.00000001	-0.0000002	0.0	-0.0000001	0.0	0.0
32	-0.00000001	0.0	0.0	0.0	0.0	0.0
33	0.00000001	0.0000001	-0.0000001	0.0	0.0	0.0
34	0.00000001	0.0000002	0.0	0.0	0.0000001	0.0000001
35	0.0	-0.0000001	0.0	0.0	0.0	-0.0000001
36	0.0	0.0000001	0.0000001	0.0	0.0	0.0
37	0.00000002	0.0	0.0	0.0	0.0	-0.0000001

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1978
MERCURY AND VENUS

DAYS 1 THRU 95 JD 2443509.5 TO 2443604.5 DATES JAN 1 THRU APR 5

A = 47.50000000 B = -1.02105263

CHEBYSHEV COEFFICIENTS

	MERCURY R A	MERCURY DEC	MERCURY DISTANCE	VENUS R A	VENUS DEC	VENUS DISTANCE
	H	O	AU	H	O	AU
0	43.1421890	-16.439472	2.0689663	44.7050103	-16.701831	3.3533490
1	4.5329579	19.491584	-0.0866083	3.8480043	18.899807	-0.0480735
2	-0.0999196	6.401210	-0.3453646	-0.1167310	2.738903	-0.0241943
3	-0.4187500	-2.916734	-0.0145614	0.0257465	-0.907535	-0.0006824
4	-0.0690946	-1.968878	0.0219494	0.0094687	-0.016435	-0.0000820
5	-0.0735305	-0.302725	0.0211784	-0.0019803	0.011339	0.0000276
6	0.0117228	-0.006396	0.0100608	-0.0000477	-0.003844	0.0000028
7	0.0087157	0.141680	-0.0015938	0.0000889	0.000408	0.0000138
8	0.0086200	0.050556	-0.0024349	0.0000189	0.000282	-0.0000071
9	0.0010123	0.002398	-0.0015150	-0.0000149	-0.000112	-0.0000165
10	-0.0010262	-0.014355	0.0000531	-0.0000236	-0.000103	0.0000041
11	-0.0007639	-0.008013	0.0004130	0.0000042	0.000020	0.0000064
12	-0.0002065	0.000565	0.0002532	0.0000073	0.000035	-0.0000012
13	0.0001932	0.002712	0.0000170	-0.0000014	-0.000014	-0.0000017
14	0.0001333	0.001785	-0.0000741	-0.0000022	-0.000008	0.0000003
15	0.0000382	0.000085	-0.0000516	0.0000019	0.000004	0.0000004
16	-0.0000377	-0.000524	-0.0000081	-0.0000001	0.000002	-0.0000001
17	-0.0000319	-0.000383	0.0000138	0.0000002	0.000005	0.0000003
18	-0.0000076	-0.000069	0.0000111	0.0000010	0.000001	-0.0000001
19	0.0000044	0.000082	0.0000022	-0.0000015	-0.000010	-0.0000004
20	0.0000061	0.000081	-0.0000023	-0.0000010	-0.000001	0.0
21	0.0000038	0.000025	-0.0000024	0.0000013	0.000004	0.0000002
22	-0.0000004	-0.000013	-0.0000007	0.0000006	0.000001	0.0
23	-0.0000022	-0.000020	0.0000004	-0.0000007	-0.000002	-0.0000001
24	-0.0000011	-0.000004	0.0000006	-0.0000001	-0.000003	0.0000001
25	0.0000005	0.000004	0.0000002	0.0000004	0.000001	0.0
26	0.0000002	0.000001	-0.0000001	0.0	0.000001	0.0
27	-0.0000001	0.000002	-0.0000001	-0.0000001	0.000003	0.0
28	-0.0000001	-0.000001	0.0	-0.0000001	0.000002	0.0000001
29	0.0	-0.000003	0.0000001	0.0	0.0	0.0
30	0.0000001	0.000001	0.0	-0.0000002	0.000001	0.0
31	0.0000001	0.000001	-0.0000001	-0.0000001	0.000001	0.0
32	0.0000001	-0.000002	0.0	0.0000001	0.000001	0.0
33	-0.0000003	0.0	0.0	-0.0000001	-0.000001	0.0000001
34	-0.0000001	0.000001	0.0	0.0	-0.000003	-0.0000001
35	0.0	0.000001	-0.0000001	0.0000001	0.000001	-0.0000001
36	0.0000003	-0.000002	0.0	-0.0000001	0.0	0.0
37	0.0000001	0.0	0.0	0.0	0.000001	0.0
38	0.0	0.000001	0.0	0.0	0.0	-0.0000001
39	-0.0000001	0.000003	0.0	-0.0000002	0.0	0.0

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1978
MERCURY AND VENUS

DAYS 91 THRU 185 JD 2443599.5 TO 2443694.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.91578947

CHEBYSHEV COEFFICIENTS

	MERCURY R A	MERCURY DEC	MERCURY DISTANCE	VENUS R A	VENUS DEC	VENUS DISTANCE
	H	O	AU	H	O	AU
0	7.3563421	30.104016	1.8894814	11.3842395	37.294499	2.7866932
1	3.6102197	7.587839	0.3514286	4.0128104	3.053340	-0.2534054
2	1.4756829	3.769676	-0.0362494	0.0037012	-5.875954	-0.0268546
3	-0.1963318	-4.710271	-0.1602519	-0.0537880	-0.156179	0.0011438
4	-0.1466418	-1.768517	0.0053406	-0.0049774	0.180945	0.0002577
5	0.0058061	0.961246	0.0049178	0.0037726	0.007970	0.0000052
6	-0.0465935	-0.075051	0.0094426	0.0003629	-0.006697	-0.0000037
7	0.0236891	0.158288	0.0042847	-0.0002121	-0.000838	0.0000138
8	0.0110157	0.048270	-0.0024533	0.0000224	0.000394	-0.0000053
9	-0.0031982	-0.089897	-0.0014601	0.0000032	0.000085	-0.0000172
10	0.0003174	0.002993	-0.0003444	-0.0000328	-0.000019	0.0000030
11	-0.0020227	0.000388	0.0001953	0.0000025	0.000020	0.0000070
12	-0.0004530	0.000735	0.0003338	0.0000097	-0.000004	-0.0000009
13	0.0006705	0.007787	0.0000778	-0.0000011	-0.000011	-0.0000014
14	0.0001361	-0.001586	-0.0000602	-0.0000025	0.000005	0.0000004
15	0.0000746	-0.001445	-0.0000544	-0.0000006	-0.000001	0.0000003
16	-0.0000513	-0.000127	-0.0000191	0.0000009	-0.000003	-0.0000001
17	-0.0000844	-0.000366	0.0000108	0.0000005	-0.000002	-0.0000003
18	0.0000002	0.000357	0.0000134	0.0000002	-0.000006	-0.0000004
19	0.0000147	0.000199	0.0000037	0.0000004	0.000003	0.0000001
20	0.0000117	-0.000053	-0.0000022	-0.0000003	0.000008	0.0000003
21	0.0000031	-0.000031	-0.0000031	-0.0000005	0.0	0.0
22	-0.0000046	-0.000042	-0.0000009	0.0000003	-0.000003	-0.0000001
23	-0.0000022	0.0	0.0000007	0.0000004	0.000003	0.0
24	-0.0000005	0.000014	0.0000006	-0.0000003	0.000001	0.0
25	0.0000006	0.000002	0.0000002	0.0	0.0	0.0
26	0.0000011	0.000001	-0.0000002	0.0000001	0.0	-0.0000001
27	0.0000002	-0.000004	-0.0000001	0.0	-0.000001	0.0
28	0.0000002	0.000001	0.0	0.0000001	0.000002	0.0
29	-0.0000003	0.000002	0.0	-0.0000001	0.000001	0.0
30	-0.0000002	-0.000001	0.0000001	-0.0000003	-0.000001	0.0
31	0.0000002	0.000001	0.0000001	0.0	-0.000003	0.0
32	0.0000001	0.000001	0.0	0.0000001	0.000001	0.0000001
33	-0.0000001	0.000001	0.0	-0.0000001	-0.000001	-0.0000001
34	-0.0000002	0.000002	0.0	0.0000002	-0.000001	0.0000001
35	0.0000003	-0.000002	0.0000001	0.0000001	0.0	0.0
36	0.0	-0.000003	-0.0000001	-0.0000001	0.000002	0.0000001
37	-0.0000002	0.0	-0.0000001	-0.0000001	-0.000001	0.0
38	-0.0000001	0.0	0.0000001	0.0	-0.000001	0.0
39	0.0	0.000002	0.0	0.0	0.000001	0.0000001

MERCURY AND VENUS

DAYS 182 THRU 276 JD 2443690.5 TO 2443785.5 DATES JULY 1 THRU OCT 3

A = 47.50000000 B = -4.83157895

CHEBYSHEV COEFFICIENTS

	MERCURY R A	MERCURY DEC	MERCURY DISTANCE	VENUS R A	VENUS DEC	VENUS DISTANCE
	H	0	AU	H	0	AU
0	20.3960181	20.378545	2.0871126	24.7899801	-7.710137	1.5575683
1	1.8513216	-9.713193	0.1667142	2.8526538	-21.093231	-0.3674259
2	0.2986031	-0.164383	0.3234938	-0.2004915	0.938256	0.0005578
3	0.7639073	-5.069318	-0.0443120	-0.0224138	0.768403	0.0036259
4	-0.1184504	-1.208470	-0.0875643	-0.0173991	-0.003177	0.0004290
5	-0.2313785	1.663199	-0.0127584	-0.0040614	0.006322	0.0001480
6	-0.0090237	0.576937	0.0193231	-0.0004175	0.001521	0.0000317
7	0.0782143	-0.379889	0.0093706	0.0000106	0.000288	0.0000163
8	0.0162351	-0.234346	-0.0029284	0.0000987	-0.000166	-0.0000091
9	-0.0231904	0.085718	-0.0031026	-0.0000351	0.000162	-0.0000156
10	-0.0082185	0.072920	-0.0001376	-0.0000624	0.000266	0.0000069
11	0.0062840	-0.023372	0.0006127	0.0000097	-0.000013	0.0000072
12	0.0029754	-0.020141	0.0001729	0.0000207	-0.000067	-0.0000021
13	-0.0018291	0.010559	-0.0000102	0.0000014	-0.000001	-0.0000015
14	-0.0008970	0.006432	0.0000043	-0.0000015	-0.000002	0.0000001
15	0.0006868	-0.005746	-0.0000300	-0.0000005	-0.000001	0.0000001
16	0.0002874	-0.003041	-0.0000447	-0.0000006	-0.000004	0.0
17	-0.0003146	0.002752	-0.0000013	-0.0000014	0.000003	-0.0000003
18	-0.0001292	0.001725	0.0000267	-0.0000027	0.000023	0.0000003
19	0.0001413	-0.001081	0.0000111	0.0000008	-0.000001	0.0000004
20	0.0000719	-0.000902	-0.0000086	0.0000031	-0.000015	-0.0000003
21	-0.0000557	0.000352	-0.0000072	-0.0000006	0.000002	-0.0000002
22	-0.0000374	0.000409	0.0000011	-0.0000016	0.000009	0.0000001
23	0.0000183	-0.000100	0.0000028	0.0	-0.000001	0.0000001
24	0.0000166	-0.000164	0.0000005	0.0000004	-0.000001	-0.0000001
25	-0.0000052	0.000028	-0.0000006	0.0	-0.000001	-0.0000001
26	-0.0000066	0.000062	-0.0000002	-0.0000001	0.000002	0.0
27	0.0000018	-0.000014	0.0000001	0.0000001	-0.000002	0.0000001
28	0.0000025	-0.000029	0.0	0.0000005	-0.000005	0.0
29	-0.0000008	0.000008	-0.0000001	0.0000002	0.0	0.0
30	-0.0000011	0.000013	0.0	-0.0000003	0.000001	0.0000001
31	0.0000006	-0.000003	-0.0000001	0.0000001	0.0	-0.0000001
32	0.0000006	-0.000005	0.0	0.0000003	-0.000003	0.0
33	-0.0000002	0.000004	0.0	0.0	0.000002	0.0
34	-0.0000003	0.000003	0.0	0.0	-0.000001	0.0000001
35	0.0000001	0.0	0.0	0.0	-0.000001	0.0
36	0.0000003	-0.000002	0.0	-0.0000001	0.000002	0.0
37	-0.0000002	-0.000002	-0.0000001	-0.0000001	0.0	0.0
38	-0.0000002	0.000003	0.0000001	-0.0000001	0.0	0.0
39	0.0	-0.000002	0.0	-0.0000001	0.000001	0.0000001

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1978
MERCURY AND VENUS

DAYS 274 THRU 368 JD 2443782.5 TO 2443877.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.76842105

CHEBYSHEV COEFFICIENTS

	MERCURY R A	MERCURY DEC	MERCURY DISTANCE	VENUS R A	VENUS DEC	VENUS DISTANCE
	H	0	AU	H	0	AU
0	31.1786963	-34.244342	2.2885297	29.9812524	-37.377089	0.7956211
1	2.1818763	-7.801381	-0.2295146	0.1060692	5.794901	0.0725998
2	-0.9110578	6.026791	0.1810788	0.4007416	-0.891525	0.1092093
3	0.2726210	-2.884391	0.1718242	0.3330750	-2.893768	-0.0106184
4	0.4490500	-1.700988	-0.0123704	-0.1088043	0.520212	-0.0073076
5	0.1147212	0.139615	-0.0531866	-0.0399436	0.557236	0.0020795
6	-0.1429333	0.668173	-0.0217292	0.0297294	-0.157977	0.0007895
7	-0.1149738	0.361686	0.0105273	0.0029871	-0.110984	-0.0004641
8	0.0089513	-0.063857	0.0131018	-0.0073124	0.053859	-0.0000943
9	0.0569195	-0.202226	0.0020401	0.0005227	0.021186	0.0001148
10	0.0240856	-0.098727	-0.0044592	0.0017122	-0.017452	0.0000153
11	-0.0150019	0.038261	-0.0030432	-0.0003637	-0.003379	-0.0000309
12	-0.0192230	0.074163	0.0004400	-0.0003873	0.005326	-0.0000028
13	-0.0024946	0.025933	0.0015622	0.0001373	0.000249	0.0000083
14	0.0082007	-0.023209	0.0005830	0.0000802	-0.001523	0.0000004
15	0.0054776	-0.027802	-0.0004167	-0.0000421	0.000114	-0.0000019
16	-0.0012702	-0.004173	-0.0004785	-0.0000142	0.000406	0.0000001
17	-0.0034236	0.012496	-0.0000494	0.0000153	-0.000090	0.0000004
18	-0.0011437	0.009591	0.0001987	0.0000018	-0.000113	-0.0000003
19	0.0011455	-0.001180	0.0001256	-0.0000095	0.000054	-0.0000001
20	0.0011893	-0.005900	-0.0000300	0.0000005	0.000035	0.0000005
21	0.0000376	-0.002768	-0.0000759	0.0000060	-0.000032	0.0
22	-0.0005961	0.001630	-0.0000249	-0.0000006	-0.000013	-0.0000002
23	-0.0003351	0.002452	0.0000241	-0.0000034	0.000021	0.0
24	0.0001334	0.000501	0.0000248	0.0000006	0.000003	0.0000002
25	0.0002456	-0.001059	0.0000012	0.0000010	-0.000010	0.0
26	0.0000606	-0.000874	-0.0000117	-0.0000003	-0.000001	-0.0000001
27	-0.0000971	0.000088	-0.0000068	-0.0000002	0.000004	0.0
28	-0.0000834	0.000531	0.0000023	0.0000001	0.000001	0.0
29	0.0000067	0.000251	0.0000046	0.0	-0.000001	0.0
30	0.0000477	-0.000150	0.0000013	0.0000006	-0.000002	-0.0000001
31	0.0000222	-0.000223	-0.0000017	0.0000001	0.0	-0.0000001
32	-0.0000138	-0.000043	-0.0000014	-0.0000005	0.000002	0.0
33	-0.0000192	0.000099	0.0	0.0000002	-0.000002	0.0
34	-0.0000030	0.000080	0.0000009	0.0	0.000002	0.0
35	0.0000088	-0.000010	0.0000004	0.0	0.000002	0.0
36	0.0000062	-0.000050	-0.0000002	0.0000002	0.0	0.0
37	-0.0000013	-0.000022	-0.0000003	0.0000002	-0.000001	0.0
38	-0.0000039	0.000017	-0.0000001	-0.0000003	0.000003	0.0000001
39	-0.0000013	0.000022	0.0000001	-0.0000002	0.000001	0.0

DAYS 1 THRU 95 JD 2443509.5 TO 2443604.5 DATES JAN 1 THRU APR 5

A = 47.50000000 B = -1.02105263

CHEBYSHEV COEFFICIENTS

	MARS R A	MARS DEC	MARS DISTANCE	JUPITER R A	JUPITER DEC	JUPITER DISTANCE
	H	0	AU	H	0	AU
0	16.2618885	47.671713	1.6577676	11.6873666	46.600003	9.3907611
1	-0.4430188	0.626457	0.2345748	-0.0270159	0.110915	0.6208241
2	0.3600652	-1.533549	0.0825676	0.1247956	0.022696	0.0732349
3	0.0581673	0.085730	-0.0136334	0.0016995	0.001583	-0.0203576
4	-0.0376050	0.082848	-0.0011470	-0.0030999	-0.005876	-0.0000459
5	0.0029188	-0.049761	0.0008744	0.0003753	-0.000138	0.0003048
6	0.0027570	0.004877	-0.0001030	0.0000231	0.000273	-0.0000254
7	-0.0009224	0.005046	-0.0000402	-0.0000172	-0.000030	-0.0000011
8	-0.0001254	-0.001962	0.0000298	0.0000005	-0.000016	0.0000160
9	0.0001985	-0.000399	0.0000094	0.0000161	0.000002	0.0000004
10	0.0000284	0.000356	-0.0000165	-0.0000001	0.000021	-0.0000171
11	-0.0000741	0.000147	-0.0000054	-0.0000115	-0.000003	0.0
12	-0.0000108	-0.000102	0.0000068	0.0000003	-0.000015	0.0000071
13	0.0000245	-0.000048	0.0000017	0.0000034	0.000001	0.0
14	0.0000023	0.000029	-0.0000019	-0.0000004	-0.000007	-0.0000020
15	-0.0000060	0.000007	-0.0000005	0.0000005	0.000003	0.0
16	0.0000001	-0.000006	0.0000004	0.0000004	0.000002	0.0000005
17	0.0000013	0.000002	-0.0000001	0.0000004	0.0	-0.0000001
18	-0.0000012	0.000008	0.0000001	0.0000002	0.000007	0.0000002
19	-0.0000001	-0.000002	0.0000003	-0.0000015	0.000001	0.0000001
20	0.0000013	-0.000008	-0.0000003	-0.0000001	-0.000008	-0.0000005
21	0.0	0.000005	-0.0000001	0.0000011	0.0	-0.0000002

DAYS 91 THRU 185 JD 2443599.5 TO 2443694.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.91578947

CHEBYSHEV COEFFICIENTS

	MARS R A	MARS DEC	MARS DISTANCE	JUPITER R A	JUPITER DEC	JUPITER DISTANCE
	H	0	AU	H	0	AU
0	18.7038731	33.326509	3.0128249	13.0085242	46.324262	11.6853918
1	1.4852801	-7.777222	0.4085862	0.6610020	-0.421637	0.4704578
2	0.0804816	-0.930154	-0.0153084	0.0436257	-0.185978	-0.0888183
3	-0.0174865	0.026494	-0.0028249	-0.0082217	-0.014029	-0.0066962
4	0.0032945	0.009228	0.0003782	0.0003066	0.002998	0.0008721
5	-0.0003304	-0.000274	-0.0000290	-0.0000075	0.000102	-0.0000207
6	0.0000447	-0.000182	0.0000097	0.0000032	-0.000035	0.0000010
7	-0.0000204	0.000087	0.0000055	0.0000002	-0.000005	0.0000045
8	0.0000330	-0.000191	0.0000104	0.0000115	-0.000010	-0.0000012
9	0.0000308	-0.000045	-0.0000159	-0.0000001	0.000023	-0.0000194
10	-0.0000336	0.000131	-0.0000093	-0.0000110	0.000003	0.0000012
11	-0.0000115	0.000020	0.0000081	0.0000016	-0.000006	0.0000112
12	0.0000127	-0.000040	0.0000033	0.0000040	0.000003	-0.0000003
13	0.0000025	-0.000002	-0.0000024	-0.0000002	0.000001	-0.0000032
14	-0.0000037	0.000016	-0.0000004	-0.0000012	0.000006	0.0000003
15	-0.0000010	0.0	0.0000005	-0.0000010	-0.000005	0.0000007
16	0.0000008	-0.000007	0.0000001	0.0000004	-0.000007	-0.0000002
17	0.0000002	-0.000002	0.0	-0.0000005	0.000001	-0.0000002
18	0.0000007	-0.000009	-0.0000003	0.0000008	-0.000008	-0.0000004
19	0.0000003	-0.000001	-0.0000003	0.0000013	0.000003	0.0000002
20	-0.0000007	0.000008	0.0000004	-0.0000004	0.000011	0.0000004
21	-0.0000006	-0.000001	0.0000002	-0.0000010	-0.000005	0.0

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1978
MARS AND JUPITER

DAYS 182 THRU 276 JD 2443690.5 TO 2443785.5 DATES JULY 1 THRU OCT 3

A = 47.50000000 B = -4.83157895

CHEBYSHEV COEFFICIENTS

	MARS R A	MARS DEC	MARS DISTANCE	JUPITER R A	JUPITER DEC	JUPITER DISTANCE
	H	O	AU	H	O	AU
0	25.1295782	-5.923370	4.2466145	15.6953203	42.105141	11.9822103
1	1.8511270	-12.018157	0.2264185	0.6822835	-1.685922	-0.3241707
2	0.0528556	-0.017277	-0.0276057	-0.0354869	-0.060461	-0.1003464
3	0.0062253	0.127005	0.0000975	-0.0066984	0.036060	0.0045636
4	0.0004165	0.007322	0.0001103	-0.0001551	0.003150	0.0008224
5	-0.0000793	0.000330	0.0000111	-0.0000145	-0.000066	0.0000282
6	0.0000033	-0.000010	-0.0000026	-0.0000005	-0.000007	-0.0000073
7	0.0000048	-0.000040	0.0000074	0.0000031	-0.000003	-0.0000013
8	0.0000262	-0.000129	-0.0000092	-0.0000034	0.000025	-0.0000152
9	-0.0000174	0.000079	-0.0000163	-0.0000120	0.000014	0.0000048
10	-0.0000214	0.000100	0.0000079	0.0000023	-0.000018	0.0000161
11	0.0000096	-0.000041	0.0000082	0.0000067	-0.000017	-0.0000029
12	0.0000081	-0.000031	-0.0000029	-0.0000001	0.000006	-0.0000066
13	-0.0000023	0.000008	-0.0000019	-0.0000021	0.000003	0.0000009
14	0.0000001	0.0	0.0000004	0.0000010	-0.000004	0.0000012
15	0.0000003	-0.000003	0.0000002	0.0000007	0.000004	0.0
16	-0.0000005	0.0	-0.0000001	-0.0000005	0.000003	-0.0000002
17	-0.0000001	-0.000002	-0.0000004	-0.0000002	-0.000001	0.0000001
18	-0.0000015	0.000013	0.0000002	-0.0000010	0.000003	0.0000004
19	0.0000005	0.0	0.0000004	-0.0000003	-0.000008	-0.0000001
20	0.0000018	-0.000013	-0.0000003	0.0000014	-0.000005	-0.0000005
21	-0.0000002	-0.000001	-0.0000002	0.0000002	0.000006	0.0000002

DAYS 274 THRU 368 JD 2443782.5 TO 2443877.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.76842105

CHEBYSHEV COEFFICIENTS

	MARS R A	MARS DEC	MARS DISTANCE	JUPITER R A	JUPITER DEC	JUPITER DISTANCE
	H	O	AU	H	O	AU
0	33.4318886	-41.433267	4.7482655	17.2981902	37.784198	9.8792759
1	2.4581145	-4.726420	0.0398046	0.0809682	-0.142742	-0.6499238
2	0.0765978	1.997467	-0.0183676	-0.1155402	0.434399	0.0438198
3	-0.0099283	0.166204	0.0013689	-0.0026708	0.013715	0.0202112
4	-0.0023262	-0.016765	0.0000554	0.0019063	-0.012008	0.0005485
5	0.0001174	-0.003711	-0.0000100	0.0003434	-0.001593	-0.0002208
6	0.0000679	0.000025	-0.0000059	0.0000082	0.000097	-0.0000275
7	0.0000208	0.000035	-0.0000017	-0.0000092	0.000068	-0.0000034
8	-0.0000074	-0.000048	-0.0000184	-0.0000092	0.000024	0.0000112
9	-0.0000337	0.000055	0.0000033	0.0000096	-0.000039	0.0000143
10	0.0000046	-0.000003	0.0000140	0.0000100	-0.000015	-0.0000118
11	0.0000138	-0.000024	-0.0000019	-0.0000070	0.000034	-0.0000085
12	-0.0000021	0.000009	-0.0000048	-0.0000047	0.000006	0.0000050
13	-0.0000047	0.000005	0.0000004	0.0000015	-0.000006	0.0000027
14	-0.0000002	0.000008	0.0000011	0.0000008	-0.000008	-0.0000011
15	0.0000021	-0.000002	0.0	0.0000008	-0.000003	-0.0000008
16	0.0000004	0.000001	-0.0000001	0.0	0.000003	0.0000001
17	0.0000006	0.000003	0.0	0.0000003	-0.000004	-0.0000001
18	0.0000005	-0.000011	-0.0000003	0.0000006	0.000005	-0.0000001
19	-0.0000023	-0.000003	-0.0000002	-0.0000014	0.000005	0.0000004
20	-0.0000005	0.000009	0.0000004	-0.0000001	-0.000007	0.0
21	0.0000014	-0.000006	0.0	0.0000011	-0.000004	-0.0000003

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1978
SATURN AND URANUS

DAYS 1 THRU 95 JD 2443509.5 TO 2443604.5 DATES JAN 1 THRU APR 5

A = 47.50000000 B = -1.02105263

CHEBYSHEV COEFFICIENTS

	SATURN R A	SATURN DEC	SATURN DISTANCE	URANUS R A	URANUS DEC	URANUS DISTANCE
	H	O	AU	H	O	AU
0	19.9717857	27.815876	16.8117560	29.8083807	-32.441633	36.8350282
1	-0.2092422	1.185106	0.0191586	0.0077014	-0.024410	-0.7262628
2	0.0004624	-0.044843	0.1651094	-0.0324088	0.139947	0.0339495
3	0.0119938	-0.064369	-0.0010801	0.0004513	-0.002602	0.0219304
4	-0.0000545	0.002513	-0.0031408	0.0005344	-0.001990	-0.0003351
5	-0.0002508	0.001351	0.0000351	0.0000162	-0.000069	-0.0002290
6	-0.0000025	-0.000079	0.0000522	-0.0000061	0.000009	-0.0000112
7	0.0000048	-0.000031	-0.0000024	-0.0000003	0.0	0.0
8	-0.0000056	0.000025	0.0000057	-0.0000017	-0.000002	-0.0000116
9	0.0000022	-0.000016	0.0000170	-0.0000051	0.000017	0.0000123
10	0.0000072	-0.000029	-0.0000082	0.0000021	-0.000004	0.0000130
11	-0.0000032	0.000022	-0.0000107	0.0000011	-0.000005	-0.0000068
12	-0.0000029	0.000006	0.0000033	-0.0000007	0.000007	-0.0000054
13	0.0000004	-0.000006	0.0000035	-0.0000004	0.000004	0.0000019
14	0.0000004	-0.000008	-0.0000009	0.0000001	0.000006	0.0000019
15	0.0000010	-0.000006	-0.0000012	0.0000016	-0.000008	-0.0000013
16	-0.0000001	0.000002	0.0000002	0.0000003	-0.000001	-0.0000003
17	0.0000001	-0.000001	0.0	0.0000004	0.0	0.0000005
18	0.0000003	0.000003	0.0000001	0.0000001	-0.000006	0.0000002
19	-0.0000012	0.000008	0.0000004	-0.0000013	0.000005	0.0000001
20	-0.0000005	-0.000003	-0.0000001	-0.0000001	0.000008	0.0000003
21	0.0000008	-0.000005	-0.0000004	0.0000010	-0.000005	-0.0000007

DAYS 91 THRU 185 JD 2443599.5 TO 2443694.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.91578947

CHEBYSHEV COEFFICIENTS

	SATURN R A	SATURN DEC	SATURN DISTANCE	URANUS R A	URANUS DEC	URANUS DISTANCE
	H	O	AU	H	O	AU
0	19.7085149	29.178459	18.4836193	29.5498625	-31.291477	35.5992007
1	0.1127933	-0.650847	0.7331804	-0.1135740	0.499276	0.1646340
2	0.0577647	-0.300384	-0.0050085	0.0079234	-0.035553	0.1539944
3	-0.0027978	0.014102	-0.0185954	0.0047422	-0.021715	-0.0057072
4	-0.0006216	0.002207	0.0007497	-0.0002100	0.000707	-0.0022765
5	0.0000933	-0.000349	0.0001040	-0.0000577	0.000292	0.0000852
6	-0.0000016	0.000021	-0.0000078	0.0000032	-0.000001	0.0000255
7	-0.0000019	0.000006	0.0000031	0.0000001	-0.000003	-0.0000023
8	0.0000041	-0.000025	0.0000102	-0.0000018	0.000010	0.0000118
9	0.0000067	-0.000017	-0.0000141	0.0000046	-0.000016	0.0000097
10	-0.0000043	0.000022	-0.0000120	0.0000026	-0.000011	-0.0000151
11	-0.0000023	0.000008	0.0000086	-0.0000013	-0.000001	-0.0000058
12	0.0000018	-0.000005	0.0000050	-0.0000015	0.000003	0.0000052
13	0.0000009	-0.000001	-0.0000027	0.0000009	-0.000002	0.0000017
14	-0.0000008	0.000010	-0.0000009	-0.0000005	0.0	-0.0000013
15	-0.0000010	0.000003	0.0000008	-0.0000013	0.000005	-0.0000004
16	0.0000003	-0.000004	0.0000001	0.0000001	-0.000003	-0.0000001
17	0.0000001	0.000002	-0.0000002	-0.0000002	0.000001	0.0000002
18	0.0000003	-0.000005	-0.0000003	0.0000007	0.000001	0.0000005
19	0.0000012	-0.000006	-0.0000002	0.0000017	-0.000011	0.0
20	-0.0000003	0.000008	0.0000003	-0.0000006	-0.000001	-0.0000001
21	-0.0000010	0.000002	0.0000003	-0.0000016	0.000007	0.0000008

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1978
SATURN AND URANUS

DAYS 182 THRU 276 JD 2443690.5 TO 2443785.5 DATES JULY 1 THRU OCT 3

A = 47.50000000 B = -4.83157895

CHEBYSHEV COEFFICIENTS

	SATURN R A	SATURN DEC	SATURN DISTANCE	URANUS R A	URANUS DEC	URANUS DISTANCE
	H	0	AU	H	0	AU
0	20.7025915	23.644150	20.2828477	29.4324340	-30.833889	37.5810931
1	0.3658803	-2.040450	0.1109599	0.0684664	-0.333740	0.7278549
2	0.0054054	-0.040415	-0.1303726	0.0292685	-0.131359	-0.0293380
3	-0.0049469	0.028617	-0.0024842	-0.0011852	0.007022	-0.0191959
4	0.0000001	0.000807	0.0011699	-0.0003203	0.001649	0.0005221
5	-0.0000023	-0.000006	0.0000231	0.0000191	-0.000121	0.0001326
6	0.0	-0.000004	-0.0000078	0.0000012	-0.000010	-0.0000039
7	0.0000011	-0.000007	0.0000011	-0.0000005	0.000005	0.0000032
8	0.0000015	0.000001	-0.0000139	0.0000018	-0.000007	0.0000009
9	-0.0000060	0.000025	-0.0000074	0.0000008	0.000001	-0.0000200
10	-0.0000030	0.000005	0.0000155	-0.0000036	0.000012	-0.0000015
11	0.0000034	-0.000019	0.0000045	-0.0000005	0.000009	0.0000127
12	0.0000017	-0.000002	-0.0000064	0.0000021	-0.000009	-0.0000010
13	-0.0000013	0.000003	-0.0000012	-0.0000001	-0.000002	-0.0000030
14	0.0000008	-0.000001	0.0000011	0.0000007	-0.000004	-0.0000002
15	0.0000007	0.000002	0.0000001	0.0000003	-0.000004	0.0000012
16	-0.0000007	0.000004	0.0	-0.0000007	0.000002	0.0000003
17	0.0	0.000003	-0.0000002	-0.0000001	-0.000003	-0.0000011
18	-0.0000013	0.000006	0.0000004	-0.0000008	0.000004	-0.0000014
19	-0.0000002	-0.000004	0.0000002	-0.0000002	0.000004	0.0000005
20	0.0000015	-0.000009	-0.0000003	0.0000017	-0.000007	-0.0000008
21	0.0000003	0.000004	-0.0000001	0.0000001	-0.000008	-0.0000005

DAYS 274 THRU 368 JD 2443782.5 TO 2443877.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.76842105

CHEBYSHEV COEFFICIENTS

	SATURN R A	SATURN DEC	SATURN DISTANCE	URANUS R A	URANUS DEC	URANUS DISTANCE
	H	0	AU	H	0	AU
0	21.8536989	17.326060	19.0220136	29.9737860	-33.252104	38.9733769
1	0.1840337	-0.934141	-0.6941174	0.1853901	-0.789080	-0.1035774
2	-0.0513797	0.324585	-0.0425751	-0.0033514	0.027436	-0.1489455
3	-0.0040409	0.025415	0.0179384	-0.0037362	0.015362	0.0020894
4	0.0003850	-0.003127	0.0011897	-0.0000182	-0.000394	0.0019440
5	0.0000782	-0.000575	-0.0001010	0.0000219	-0.000087	0.0000071
6	0.0000029	-0.000017	-0.0000143	0.0000006	-0.000006	-0.0000180
7	-0.0000011	0.000007	-0.0000040	0.0000005	-0.000003	-0.0000009
8	-0.0000053	0.000027	0.0000028	-0.0000011	-0.000006	-0.0000120
9	-0.0000001	-0.000006	0.0000194	-0.0000044	0.000020	0.0000125
10	0.0000059	-0.000026	-0.0000029	0.0000013	-0.000005	0.0000135
11	-0.0000013	0.000013	-0.0000114	0.0000011	-0.000007	-0.0000074
12	-0.0000030	0.000015	0.0000013	-0.0000011	0.000009	-0.0000064
13	0.0	0.000001	0.0000037	-0.0000006	0.000004	0.0000025
14	0.0000002	-0.000001	0.0	0.0	0.000007	0.0000014
15	0.0000011	-0.000010	-0.0000009	0.0000018	-0.000001	-0.0000003
16	0.0	0.000004	-0.0000002	0.0	-0.000004	-0.0000003
17	0.0000002	-0.000002	0.0000001	0.0000003	-0.000002	0.0000002
18	0.0000003	-0.000001	0.0	0.0000006	-0.000007	-0.0000001
19	-0.0000012	0.000011	0.0000004	-0.0000016	0.000006	0.0000002
20	-0.0000005	-0.000003	0.0000001	-0.0000001	0.000008	0.0000005
21	0.0000016	-0.000007	-0.0000003	0.0000014	-0.000005	0.0000003

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1978
NEPTUNE AND PLUTO

DAYS 1 THRU 95 JD 2443509.5 TO 2443604.5 DATES JAN 1 THRU APR 5

A = 47.50000000 B = -1.02105263

CHEBYSHEV COEFFICIENTS

	NEPTUNE R A	NEPTUNE DEC	NEPTUNE DISTANCE	PLUTO R A *	PLUTO DEC *	PLUTO DISTANCE
	H	O	AU	H	O	AU
0	34.2465634	-42.875564	61.0982175	26.83522593	19.6885643	59.7215562
1	0.0550379	-0.042024	-0.7086448	-0.03173990	0.5565650	-0.5537392
2	-0.0196614	0.028850	-0.0526271	-0.01622054	0.0367476	0.1038179
3	-0.0011500	-0.000209	0.0205875	0.00150688	-0.0211409	0.0163549
4	0.0002684	-0.000308	0.0008007	0.00028267	-0.0007829	-0.0016402
5	0.0000172	0.000010	-0.0001834	-0.00001283	0.0002494	-0.0001850
6	-0.0000010	-0.000010	-0.0000172	-0.00000427	0.0000207	0.0000090
7	-0.0000003	-0.000002	0.0000001	0.00000012	-0.0000014	-0.0000004
8	0.0000003	-0.000006	-0.0000158	-0.00000160	0.0000108	-0.0000058
9	-0.0000043	0.000005	0.0000020	-0.00000112	-0.0000052	0.0000172
10	0.0000002	-0.000003	0.0000162	0.00000189	-0.0000128	0.0000064
11	0.0000006	-0.000004	-0.0000016	0.00000068	0.0000029	-0.0000104
12	-0.0000003	0.000004	-0.0000067	-0.00000076	0.0000055	-0.0000026
13	-0.0000009	0.000002	-0.0000003	-0.00000025	-0.0000007	0.0000033
14	-0.0000003	0.000008	0.0000010	0.00000021	-0.0000016	0.0000008
15	0.0000017	0.0	-0.0000003	0.00000008	0.0000004	-0.0000009
16	0.0000001	-0.000002	-0.0000007	-0.00000005	0.0000003	-0.0000002
17	0.0000003	0.000001	0.0000005	0.0	-0.0000003	0.0
18	0.0	-0.000006	-0.0000010	0.0	0.0000003	0.0
19	-0.0000015	0.0	0.0000004	-0.00000001	-0.0000001	0.0000003
20	-0.0000004	0.000008	0.0000009	0.0	-0.0000005	0.0000002
21	0.0000012	0.0	0.0	0.00000001	0.0000001	-0.0000003

DAYS 91 THRU 185 JD 2443599.5 TO 2443694.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.91578947

CHEBYSHEV COEFFICIENTS

	NEPTUNE R A	NEPTUNE DEC	NEPTUNE DISTANCE	PLUTO R A *	PLUTO DEC *	PLUTO DISTANCE
	H	O	AU	H	O	AU
0	34.1913980	-42.717675	58.9675225	26.63294883	21.0739454	59.5263722
1	-0.0753147	0.107517	-0.2655239	-0.05426355	0.0407840	0.4548547
2	-0.0078590	0.004735	0.1471976	0.01118858	-0.1403820	0.1100011
3	0.0028854	-0.003814	0.0073483	0.00206329	-0.0025311	-0.0144231
4	0.0001222	-0.000161	-0.0021417	-0.00020897	0.0021959	-0.0013662
5	-0.0000310	0.000023	-0.0000681	-0.00001680	-0.0000399	0.0001507
6	-0.0000025	0.000012	0.0000183	0.00000217	-0.0000218	0.0000146
7	0.0	-0.000001	-0.0000009	-0.00000025	0.0000029	-0.0000012
8	-0.0000021	0.000008	0.0000056	-0.00000038	-0.0000068	0.0000138
9	0.0000020	-0.000004	0.0000185	0.00000240	-0.0000119	0.0000013
10	0.0000025	-0.000003	-0.0000074	0.00000041	0.0000078	-0.0000164
11	0.0000004	-0.000005	-0.0000122	-0.00000149	0.0000079	-0.0000012
12	-0.0000016	-0.000004	0.0000030	-0.00000019	-0.0000032	0.0000070
13	0.0000005	0.000001	0.0000041	0.00000045	-0.0000027	0.0000003
14	-0.0000005	-0.000005	-0.0000013	-0.00000001	0.0000008	-0.0000018
15	-0.0000014	0.000004	0.0000001	-0.00000010	0.0000003	0.0000003
16	0.0000003	0.000003	-0.0000002	0.00000004	-0.0000001	0.0000004
17	-0.0000003	0.000001	-0.0000010	0.00000004	0.0	0.0
18	0.0000003	0.000006	0.0000001	0.00000002	-0.0000001	-0.0000001
19	0.0000014	-0.000005	0.0000003	-0.00000002	0.0000003	-0.0000003
20	-0.0000007	-0.000012	-0.0000007	-0.00000004	0.0	0.0
21	-0.0000008	0.000007	0.0000002	0.0	-0.0000003	0.0000004

* ASTROMETRIC POSITION, EQUATOR AND EQUINOX 1950.0

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1978
NEPTUNE AND PLUTO

DAYS 182 THRU 276 JD 2443690.5 TO 2443785.5 DATES JULY 1 THRU OCT 3

A = 47.50000000 B = -4.83157895

CHEBYSHEV COEFFICIENTS

	NEPTUNE R A	NEPTUNE DEC	NEPTUNE DISTANCE	PLUTO R A *	PLUTO DEC *	PLUTO DISTANCE
	H	O	AU	H	O	AU
0	33.9745026	-42.486341	59.9161910	26.65150025	19.5699077	61.7039605
1	-0.0165751	-0.014835	0.6902770	0.06641873	-0.7419498	0.5270445
2	0.0196952	-0.031123	0.0563770	0.01457837	-0.0326004	-0.0909115
3	0.0008976	-0.000512	-0.0195359	-0.00130845	0.0163588	-0.0145439
4	-0.0002847	0.000555	-0.0007123	-0.00015865	0.0002453	0.0011244
5	-0.0000036	0.000010	0.0001667	0.00001010	-0.0000935	0.0001042
6	0.0000022	-0.000004	0.0000088	0.00000124	-0.0000013	-0.0000073
7	-0.0000004	0.000002	0.0000010	0.00000006	-0.0000018	0.0000023
8	0.0000008	-0.000005	0.0000081	0.00000167	-0.0000050	-0.0000056
9	0.0000022	0.000001	-0.0000152	-0.00000078	0.0000126	-0.0000170
10	-0.0000024	-0.000001	-0.0000104	-0.00000194	0.0000052	0.0000066
11	-0.0000017	0.000008	0.0000104	0.00000054	-0.0000081	0.0000108
12	0.0000015	-0.000002	0.0000047	0.00000082	-0.0000021	-0.0000030
13	0.0000004	-0.000003	-0.0000042	-0.00000015	0.0000023	-0.0000032
14	0.0000008	-0.000003	-0.0000015	-0.00000016	0.0000004	0.0000006
15	0.0000005	-0.000008	0.0000002	0.0	-0.0000002	0.0000004
16	-0.0000006	0.0	0.0000004	0.00000002	0.0	0.0
17	0.0	-0.000002	-0.0000001	0.00000001	0.0000003	-0.0000002
18	-0.0000012	0.000001	-0.0000005	-0.00000005	-0.0000001	0.0000001
19	-0.0000003	0.000010	0.0	0.00000001	-0.0000006	0.0000005
20	0.0000019	0.000001	0.0000001	0.00000006	0.0000001	-0.0000002
21	0.0	-0.000008	-0.0000001	-0.00000002	0.0000004	-0.0000004

DAYS 274 THRU 368 JD 2443782.5 TO 2443877.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.76842105

CHEBYSHEV COEFFICIENTS

	NEPTUNE R A	NEPTUNE DEC	NEPTUNE DISTANCE	PLUTO R A *	PLUTO DEC *	PLUTO DISTANCE
	H	O	AU	H	O	AU
0	34.1781479	-42.883945	62.0983945	26.99903370	17.2856440	61.8815256
1	0.1121966	-0.164852	0.2780200	0.09460111	-0.3100050	-0.4576095
2	0.0077281	0.000655	-0.1434147	-0.00880468	0.1288476	-0.1183156
3	-0.0024999	0.004193	-0.0082713	-0.00216739	0.0071207	0.0116549
4	-0.0001017	-0.000125	0.0019502	0.00007563	-0.0015541	0.0018073
5	0.0000189	-0.000046	0.0000803	0.00001909	-0.0001043	-0.0000758
6	0.0000010	-0.000009	-0.0000202	-0.00000059	0.0000104	-0.0000183
7	0.0	-0.000002	-0.0000004	0.00000008	0.0000018	-0.0000025
8	0.0000002	-0.000010	-0.0000138	-0.00000154	0.0000105	-0.0000064
9	-0.0000038	-0.000002	0.0000017	-0.00000123	-0.0000030	0.0000168
10	-0.0000003	0.000002	0.0000169	0.00000170	-0.0000119	0.0000074
11	0.0000006	-0.000003	-0.0000005	0.00000073	0.0000015	-0.0000102
12	-0.0000002	0.000003	-0.0000059	-0.00000070	0.0000050	-0.0000029
13	-0.0000009	0.000002	0.0000004	-0.00000024	-0.0000001	0.0000032
14	-0.0000006	0.000007	0.0000014	0.00000018	-0.0000015	0.0000009
15	0.0000013	0.000003	0.0000005	0.00000008	-0.0000002	-0.0000006
16	0.0000005	-0.000006	-0.0000007	-0.00000002	0.0000004	-0.0000003
17	0.0000003	0.000001	0.0000007	-0.00000003	0.0	0.0
18	0.0000003	-0.000011	-0.0000007	-0.00000003	0.0	-0.0000001
19	-0.0000013	-0.000003	-0.0000009	-0.00000001	0.0	0.0000002
20	-0.0000001	0.000009	0.0000009	0.00000001	-0.0000001	0.0000003
21	0.0000012	0.000001	-0.0000002	0.00000005	0.0000001	-0.0000002

* ASTROMETRIC POSITION, EQUATOR AND EQUINOX 1950.0

Section E: EXPRESSIONS FOR EXTENDED PERIODS OF TIME

With one exception the Chebyshev series of this section provide data referred to the equator and equinox of date. The exception concerns the right ascension and declination of Pluto, which are astrometric (*i.e.*, free of the effect of stellar aberration, except for the elliptic part) and are referred to the mean equator and equinox of 1950.0.

The trigonometric series provide data referred to the equator and equinox of date, again with one exception. This exception is the series for the Sun's geocentric, rectangular coordinates and velocities (X, Y, Z, $\dot{X}$, $\dot{Y}$, $\dot{Z}$), which are referred to the mean equator and equinox of 1950.0.

The unit of distance for the Sun and planets is the Astronomical Unit; the unit of distance for the Moon is the Earth's radius.

CHEBYSHEV APPROXIMATION OF SIDEREAL TIME FOR YEAR 1978

DAYS 1 THRU 365 JD 2443509.5 TO 2443874.5 DATES JAN 1 THRU DEC 31

A = 182.50000000 B = -1.00547945

CHEBYSHEV COEFFICIENTS

	APP S T	EQ OF EQ	NUT LON	NUT OBL
	H	S	"	"
0	37.35622812	0.0427	0.6973	-18.7150
1	11.99198297	-0.2153	-3.5207	-0.1319
2	0.00000387	0.0139	0.2280	-0.2363
3	-0.00000002	-0.0001	-0.0010	-0.0170
4	0.00000539	0.0194	0.3173	-0.3327
5	0.00001527	0.0550	0.8990	0.1528
6	-0.00000393	-0.0141	-0.2313	0.2909
7	-0.00000544	-0.0196	-0.3202	-0.0685
8	0.00000064	0.0023	0.0378	-0.0669
9	0.00000191	0.0069	0.1124	-0.0202
10	0.00000006	0.0002	0.0034	0.0056
11	0.00000057	0.0021	0.0337	-0.0126
12	0.00000035	0.0012	0.0203	0.0043
13	-0.00000048	-0.0017	-0.0284	0.0143

CHEBYSHEV APPROXIMATION OF SOLAR COORDINATES FOR YEAR 1978

DAYS 1 THRU 365 JD 2443509.5 TO 2443874.5 DATES JAN 1 THRU DEC 31

A = 182.50000000 B = -1.00547945

CHEBYSHEV COEFFICIENTS

	R A	DEC	DISTANCE	S D	EPHEM TR
	H	O	AU	"	H
0	61.3777303	-13.370167	1.99009689	32.20343	24.0233964
1	11.8530741	-2.397552	0.00039803	-0.00646	-0.1384803
2	0.0271321	-22.518807	-0.01626805	0.26193	0.0297828
3	0.0705458	2.718050	-0.00046131	0.00737	0.0706606
4	0.0402596	6.596643	0.00494387	-0.07779	0.0417551
5	0.1048693	-0.366341	0.00006414	-0.00088	0.1040937
6	-0.0304652	-0.493342	-0.00039801	0.00516	-0.0318255
7	-0.0436008	0.065245	0.00000387	-0.00012	-0.0433244
8	0.0070793	0.073290	0.00000641	0.00018	0.0073673
9	0.0073884	-0.038222	0.00000441	-0.00006	0.0073185
10	-0.0020107	-0.035710	0.00000103	-0.00006	-0.0020844
11	-0.0017174	0.011904	0.00000464	-0.00006	-0.0016747
12	0.0010052	0.008590	-0.00000410	0.00009	0.0010431
13	0.0006983	-0.003012	0.00000265	-0.00004	0.0006806
14	-0.0003295	-0.001756	-0.00000646	0.00013	-0.0003468
15	-0.0001964	0.001044	-0.00000035	0.00001	-0.0001900
16	0.0001270	0.000514	-0.00000566	0.00008	0.0001269
17	0.0000224	-0.000450	-0.00000441	0.00007	0.0000178
18	-0.0000362	-0.000096	-0.00000084	0.00002	-0.0000385
19	-0.0000393	0.000094	-0.00000439	0.00007	-0.0000397
20	-0.0000029	0.000091	0.00000548	-0.00008	0.0000009
21	0.0000005	0.000017	-0.00000073	-0.00001	0.0000002
22	-0.0000221	-0.000027	0.00000617	-0.00012	-0.0000200
23	0.0000248	0.000073	0.00000438	-0.00006	0.0000269

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1978
MERCURY AND VENUS

DAYS 1 THRU 365 JD 2443509.5 TO 2443874.5 DATES JAN 1 THRU DEC 31

A = 182.50000000 B = -1.00547945

CHEBYSHEV COEFFICIENTS

	MERCURY R A	MERCURY DEC	MERCURY DISTANCE	VENUS R A	VENUS DEC	VENUS DISTANCE
	H	O	AU	H	O	AU
0	60.6029250	-15.472620	2.0543854	62.0285632	-15.772561	2.1253347
1	12.2314584	-2.041124	-0.0153936	10.8691958	-2.307388	-0.7800691
2	-0.8429873	-20.130912	0.0031274	-2.3848494	-15.908980	0.0013969
3	-0.2059361	3.336578	-0.0073951	-0.7417821	12.337441	0.2041857
4	-0.5265800	7.120997	-0.1055700	0.1614079	6.580347	0.0710333
5	-0.0673903	0.075813	0.1500388	0.4390146	-6.116075	0.0069102
6	-0.1794524	1.871633	-0.0006999	0.2054785	-2.691617	-0.0082314
7	-0.3833354	-2.875041	0.1643405	0.1136393	-0.200616	-0.0106922
8	0.7949732	-1.565392	0.1395674	0.0163161	0.014286	-0.0079185
9	0.5543501	-0.686788	-0.1554153	-0.1084050	0.302755	-0.0022740
10	-0.3602587	-2.331025	-0.0995715	-0.0926771	0.573953	0.0015332
11	-0.1550878	2.455662	0.0642637	-0.0173136	0.372695	0.0023755
12	0.2314640	2.422425	0.0079484	0.0229551	0.005700	0.0015354
13	-0.0058069	-2.351656	-0.0313658	0.0283778	-0.149411	0.0003683
14	-0.1004941	-0.895188	-0.0060876	0.0200708	-0.157140	-0.0004113
15	-0.0986354	1.801806	-0.0100912	0.0050320	-0.108314	-0.0005876
16	-0.1150092	0.382193	0.0126711	-0.0081162	-0.021929	-0.0003822
17	0.0454394	-0.385620	0.0234203	-0.0107442	0.049711	-0.0000741
18	0.1047902	-0.157514	0.0014858	-0.0056135	0.064992	0.0001281
19	-0.0020538	-0.438027	-0.0024463	-0.0000113	0.037865	0.0001642
20	-0.0070485	0.042624	-0.0049604	0.0029933	0.003269	0.0001086
21	0.0105446	0.369185	-0.0075252	0.0032887	-0.018950	0.0000129
22	-0.0052359	-0.140408	0.0068660	0.0017019	-0.023363	-0.0000370
23	0.0307387	-0.192598	0.0050056	-0.0002061	-0.013699	-0.0000475
24	0.0152232	0.028423	-0.0092354	-0.0012067	-0.000366	-0.0000321
25	-0.0497811	0.010089	-0.0045978	-0.0010745	0.007942	0.0000010
26	-0.0281642	0.139210	0.0043163	-0.0004193	0.008681	0.0000078
27	0.0207267	0.132890	0.0030196	0.0001538	0.004505	0.0000124
28	0.0110486	-0.136481	0.0003683	0.0004197	-0.000234	0.0000095
29	-0.0049341	-0.102774	-0.0006301	0.0003225	-0.003047	-0.0000048
30	-0.0028270	0.106408	-0.0004052	0.0000808	-0.003142	0.0000013
31	0.0000165	0.047013	0.0003113	-0.0000680	-0.001419	0.0000014
32	0.0071072	-0.072586	-0.0000239	-0.0001220	0.000192	-0.0000044
33	0.0080189	-0.034321	0.0001802	-0.0000766	0.000962	0.0000032
34	-0.0022631	0.008714	0.0001281	-0.0000025	0.001064	-0.0000029
35	-0.0057975	0.006329	-0.0009973	-0.0000031	0.000650	-0.0000096
36	-0.0019678	0.017120	-0.0005644	-0.0000064	0.000036	0.0000055
37	-0.0003225	0.007080	0.0007158	0.0000413	-0.000423	0.0000114
38	0.0009628	-0.012442	0.0005078	0.0000520	-0.000522	-0.0000028
39	0.0007145	0.003882	-0.0002034	-0.0000012	-0.000259	-0.0000075
40	-0.0022257	0.012590	-0.0002348	-0.0000329	0.000086	0.0000004
41	-0.0010214	-0.002455	0.0001324	-0.0000204	0.000204	0.0000028
42	0.0029835	-0.003465	0.0002250	-0.0000034	0.000150	0.0
43	0.0019253	-0.003921	-0.0001152	0.0000040	0.000073	-0.0000008
44	-0.0012415	-0.007863	-0.0001187	0.0000066	-0.000006	0.0000003
45	-0.0007562	0.005048	0.0001272	0.0000073	-0.000066	0.0000005
46	0.0004859	0.005840	-0.0000734	0.0000032	-0.000078	-0.0000001
47	0.0000263	-0.009184	-0.0001831	-0.0000012	-0.000034	-0.0000002
48	-0.0003230	-0.001748	0.0000928	-0.0000022	0.000010	-0.0000002
49	-0.0003567	0.010023	0.0001245	-0.0000024	0.000027	-0.0000002

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1978

MARS, JUPITER, SATURN AND URANUS

DAYS 1 THRU 365 JD 2443509.5 TO 2443874.5 DATES JAN 1 THRU DEC 31

A = 182.50000000 B = -1.00547945

CHEBYSHEV COEFFICIENTS

	MARS R A	MARS DEC	MARS DISTANCE	JUPITER R A	JUPITER DEC	JUPITER DISTANCE
	H	0	AU	H	0	AU
0	24.3557647	5.655744	3.2986465	14.4662398	42.790571	10.1170935
1	5.5113294	-27.853498	0.9914935	1.7239435	-2.708411	0.1646593
2	1.6411076	-4.658261	-0.1708485	0.0813145	-0.664463	-0.9747384
3	-0.4288501	5.089712	-0.1225425	-0.4121890	0.649583	-0.0633543
4	0.2277385	0.963602	0.0639043	0.0042284	0.488425	0.1855238
5	-0.0138651	0.216105	-0.0162985	0.0045694	0.008755	0.0006541
6	-0.0726165	-0.120077	0.0030548	-0.0050163	-0.066600	0.0030952
7	0.0452942	-0.026168	0.0010899	0.0064896	-0.004264	0.0009218
8	-0.0234877	0.037397	-0.0016752	-0.0003054	-0.005939	-0.0016022
9	0.0069529	-0.061536	0.0011133	0.0004530	-0.002247	0.0000850
10	0.0017149	0.037728	-0.0005114	0.0001156	0.001280	-0.0001325
11	-0.0033933	-0.012712	0.0001343	-0.0001261	-0.000087	-0.0000191
12	0.0028046	-0.000762	0.0000361	0.0000263	0.000223	0.0000151
13	-0.0014470	0.006155	-0.0000742	-0.0000254	0.000082	-0.0000096
14	0.0003806	-0.005627	0.0000542	-0.0000052	-0.000021	0.0000079
15	0.0001568	0.003219	-0.0000316	-0.0000007	0.000030	-0.0000023
16	-0.0002924	-0.001065	0.0000039	-0.0000052	-0.000001	0.0000058
17	0.0002349	-0.000251	-0.0000016	0.0000027	-0.000002	0.0000016
18	-0.0001289	0.000650	-0.0000095	-0.0000034	-0.000003	0.0000041
19	0.0000299	-0.000592	0.0000049	0.0000051	-0.000011	0.0000054
20	0.0000061	0.000351	-0.0000052	0.0000005	-0.000005	-0.0000005
21	-0.0000415	-0.000101	0.0000067	0.0000031	-0.000010	0.0000047
22	0.0000367	-0.000036	0.0000013	0.0000051	0.0	-0.0000055
23	-0.0000318	0.000117	0.0000043	-0.0000011	-0.000005	-0.0000009

	SATURN R A	SATURN DEC	SATURN DISTANCE	URANUS R A	URANUS DEC	URANUS DISTANCE
	H	0	AU	H	0	AU
0	20.7555956	23.422497	18.2771026	29.7894961	-32.389969	37.6102236
1	0.5682255	-3.146616	0.5799302	0.0788627	-0.366195	0.5186157
2	0.3122959	-1.695790	-0.5999110	0.1605015	-0.709447	0.5614589
3	-0.1549186	0.907720	-0.4850582	0.0765813	-0.316234	-0.5361226
4	-0.0664692	0.364774	0.1694809	-0.0508631	0.236335	-0.1602679
5	0.0258438	-0.110119	0.0457164	-0.0092337	0.043294	0.0853018
6	-0.0042931	0.022239	-0.0146777	0.0064268	-0.031844	0.0101913
7	-0.0014758	-0.002911	0.0040556	-0.0003473	-0.001225	-0.0068492
8	0.0019592	-0.008090	-0.0001104	-0.0006704	0.003859	0.0007631
9	-0.0003990	0.003021	-0.0008563	0.0002261	-0.000506	0.0004581
10	-0.0000799	-0.000494	0.0002615	0.0000546	-0.000471	-0.0002244
11	0.0001117	-0.000334	-0.0000262	-0.0000395	0.000152	-0.0000254
12	-0.0000416	0.000299	-0.0000325	0.0000010	0.000039	0.0000271
13	-0.0000011	-0.000083	0.0000121	0.0000080	-0.000037	-0.0000040
14	0.0000047	0.0	-0.0000033	-0.0000014	-0.000002	-0.0000096
15	-0.0000037	0.000023	-0.0000030	-0.0000005	-0.000001	0.0000010
16	-0.0000017	0.000003	0.0000005	0.0000013	-0.000013	-0.0000069
17	0.0000007	-0.000002	0.0000038	-0.0000006	0.000002	0.0000022
18	-0.0000016	0.000008	-0.0000003	0.0000004	-0.000005	-0.0000026
19	-0.0000004	-0.000003	0.0000081	-0.0000017	0.000005	0.0000031
20	0.0000012	-0.000005	0.0000003	0.0000003	0.000001	0.0000036
21	-0.0000011	0.000009	0.0000054	-0.0000019	0.000005	0.0000013
22	0.0000042	-0.000015	0.0000002	0.0000012	-0.000007	0.0000080
23	0.0	0.000003	-0.0000033	0.0000005	-0.000006	-0.0000001

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1978
NEPTUNE AND PLUTO

DAYS 1 THRU 365 JD 2443509.5 TO 2443874.5 DATES JAN 1 THRU DEC 31

A = 182.50000000 B = -1.00547945

CHEBYSHEV COEFFICIENTS

	NEPTUNE R A	NEPTUNE DEC	NEPTUNE DISTANCE	PLUTO R A *	PLUTO DEC *	PLUTO DISTANCE
	H	O	AU	H	O	AU
0	34.1771922	-42.807957	61.0896634	26.84970548	18.9181859	60.7807382
1	0.0042950	-0.032879	0.2263967	0.05859624	-0.6883743	0.5030085
2	0.0501485	-0.109967	0.8947204	0.11247165	-0.7684338	0.0977836
3	0.0821494	-0.096029	-0.2590711	0.01717135	0.2896562	-0.6259871
4	-0.0162613	0.036155	-0.2717071	-0.03413246	0.2230020	-0.0225434
5	-0.0129226	0.017471	0.0419996	-0.00113413	-0.0524997	0.0913019
6	0.0021417	-0.002586	0.0246672	0.00310459	-0.0140615	-0.0019569
7	0.0009377	-0.002292	-0.0035185	-0.00045532	0.0058753	-0.0041846
8	-0.0002587	-0.000105	-0.0009335	-0.00009681	-0.0011085	0.0010065
9	-0.0000503	0.000331	0.0002901	0.00010433	-0.0005054	-0.0001665
10	0.0000333	0.000027	0.0000052	-0.00001116	0.0002898	-0.0001254
11	0.0000044	-0.000047	-0.0000293	-0.00000918	0.0000033	0.0000347
12	-0.0000029	-0.000007	-0.0000040	0.00000269	-0.0000278	0.0000026
13	0.0000013	0.000012	0.0000049	0.00000085	0.0000071	-0.0000075
14	0.0000006	0.000001	-0.0000062	-0.00000096	0.0000065	-0.0000041
15	-0.0000005	-0.000005	0.0	0.00000012	-0.0000016	-0.0000003
16	0.0000016	-0.000007	-0.0000087	-0.00000054	0.0000063	-0.0000057
17	-0.0000007	0.0	-0.0000006	-0.00000046	0.0000003	0.0000034
18	0.0000007	-0.000005	-0.0000040	-0.00000028	0.0000027	-0.0000025
19	-0.0000014	0.000001	-0.0000017	-0.00000075	0.0000003	0.0000056
20	-0.0000002	0.0	0.0000045	0.00000029	-0.0000026	0.0000026
21	-0.0000013	-0.000004	-0.0000007	-0.00000044	0.0000006	0.0000031
22	0.0000003	-0.000007	0.0000086	0.00000065	-0.0000061	0.0000054
23	0.0000009	-0.000004	0.0000003	0.00000034	-0.0000002	-0.0000028

* ASTROMETRIC POSITION, EQUATOR AND EQUINOX 1950.0

SUN $X_{1950.0}$

	AU										
	0.999860		COS (				L				)
-	0.025127		COS (	G		-	L				)
+	0.008374		COS (	G		+	L				)
+	0.000105		COS (	2G		+	L				)
+	0.000063	T	COS (	G		-	L				)
+	0.000035		COS (	2G		-	L				)
-	0.000026		SIN (	G		-	L			- J	)
-	0.000021	T	COS (	G		+	L				)
+	0.000018		SIN (	2G		+	L	- 2V			)
+	0.000017		COS (		C						)
-	0.000014		COS (		C	-	2L				)
+	0.000012		COS (	4G		+	L		- 8M	+ 3J	)
-	0.000012		COS (	4G		-	L		- 8M	+ 3J	)
-	0.000012		COS (	G		+	L	- V			)
+	0.000011		COS (	2G		+	L	- 2V			)
+	0.000011		COS (	2G		-	L			- 2J	)

SUN $Y_{1950.0}$

	AU										
	0.917308		SIN (				L				)
+	0.023053		SIN (	G		-	L				)
+	0.007683		SIN (	G		+	L				)
+	0.000097		SIN (	2G		+	L				)
-	0.000057	T	SIN (	G		-	L				)
-	0.000032		SIN (	2G		-	L				)
-	0.000024		COS (	G		-	L			- J	)
-	0.000019	T	SIN (	G		+	L				)
-	0.000017		COS (	2G		+	L	- 2V			)
+	0.000016		SIN (		C						)
+	0.000013		SIN (		C	-	2L				)
+	0.000011		SIN (	4G		+	L		- 8M	+ 3J	)
+	0.000011		SIN (	4G		-	L		- 8M	+ 3J	)
-	0.000011		SIN (	G		+	L	- V			)
+	0.000010		SIN (	2G		+	L	- 2V			)
-	0.000010		SIN (	2G		-	L			- 2J	)

SUN $Z_{1950.0}$

	AU							
	0.397825		SIN (			L		)
+	0.009998		SIN (	G	-	L		)
+	0.003332		SIN (	G	+	L		)
+	0.000042		SIN (	2G	+	L		)
-	0.000025	T	SIN (	G	-	L		)
-	0.000014		SIN (	2G	-	L		)
-	0.000010		COS (	G	-	L	- J	)

SUN $\dot{X}_{1950.0}$

	AU/DAY						
-	0.017200		SIN (			L	)
-	0.000288		SIN (	G		+ L	)
-	0.000005		SIN (	2G		+ L	)
-	0.000004		SIN (		C		)
+	0.000003		SIN (		C	- 2L	)
+	0.000001	T	SIN (	G		+ L	)
-	0.000001		SIN (	2G		- L	)

SUN $\dot{Y}_{1950.0}$

	AU/DAY						
	0.015780		COS (			L	)
+	0.000264		COS (	G		+ L	)
+	0.000005		COS (	2G		+ L	)
+	0.000004		COS (		C		)
+	0.000003		COS (		C	- 2L	)
-	0.000001	T	COS (	G		+ L	)

SUN $\dot{Z}_{1950.0}$

	AU/DAY					
	0.006843	COS (			L	)
+	0.000115	COS (	G		+ L	)
+	0.000002	COS (	2G		+ L	)
+	0.000002	COS (		C		)
+	0.000001	COS (		C	- 2L	)

TRIGONOMETRIC SERIES FOR THE COORDINATES OF THE SUN

SUN THETA

	AU										
	0.397930		SIN (				L				)
+	0.009999		SIN (	G			- L				)
+	0.003334		SIN (	G			+ L				)
-	0.000208	T	SIN (				L				)
+	0.000042		SIN (	2G			+ L				)
-	0.000040		COS (				L				)
-	0.000039		SIN (		N		- L				)
-	0.000030	T	SIN (	G			- L				)
-	0.000014		SIN (	2G			- L				)
-	0.000010		COS (	G			- L			- J	)
-	0.000010	T	SIN (	G			+ L				)

SUN RHO

	AU						
	1.000421						
-	0.033503		COS (	G			)
-	0.000140		COS (	2G			)
+	0.000084	T	COS (	G			)
-	0.000033		SIN (	G		- J	)
+	0.000027		SIN (	2G	- 2V		)

SUN PHI

	AU										
-	0.041295		SIN (				2L				)
+	0.032116		SIN (	G							)
-	0.001038		SIN (	G			- 2L				)
-	0.000346		SIN (	G			+ 2L				)
-	0.000095										
-	0.000080	T	SIN (	G							)
-	0.000079		SIN (		N						)
+	0.000068		SIN (	2G							)
+	0.000046	T	SIN (				2L				)
+	0.000030		SIN (			C	- L				)
-	0.000025		COS (	G						- J	)
+	0.000024		SIN (	4G					- 8M	+ 3J	)
-	0.000019		SIN (	G				- V			)
-	0.000017		COS (	2G				- 2V			)

MOON THETA

	● RADII												
	23.89684		SIN (					B			+	N	)
+	4.95372		SIN (					B					)
+	1.96763		SIN (	A			-	B			-	N	)
+	0.65973		SIN (	A			+	B			+	N	)
+	0.40248		SIN (	A			-	B					)
-	0.38899		SIN (	A			+	B	-	2D	+	N	)
-	0.20017		SIN (					B	-	2D	+	N	)
-	0.18354		SIN (					B	-	2D			)
-	0.14511		SIN (	A			-	B	-	2D	-	N	)
+	0.13622		SIN (	A			+	B					)
-	0.06505		SIN (	A			+	B	-	2D			)
-	0.04771		SIN (					B			-	N	)
+	0.04732		SIN (					B	+	2D	+	N	)
-	0.03982		SIN (			G	-	B			-	N	)
-	0.03759		SIN (			G	+	B			+	N	)
-	0.02994		SIN (	A			-	B	-	2D			)
+	0.02700		SIN (	2A			+	B			+	N	)
-	0.01868		SIN (	2A			+	B	-	2D	+	N	)
-	0.01652		SIN (	A	+	G	+	B	-	2D	+	N	)
-	0.01434		SIN (			G	+	B	-	2D	+	N	)
-	0.01250	T	SIN (					B			+	N	)
+	0.01064		SIN (					B	-	D	+	N	)
+	0.00970		SIN (					B	+	2D			)
+	0.00965		SIN (	A	-	G	-	B			-	N	)
-	0.00947		SIN (	2A			-	B			-	N	)
-	0.00929		SIN (			G	+	B	-	2D			)
-	0.00713		SIN (	A	+	G	-	B	-	2D	-	N	)
-	0.00638		SIN (	A	+	G	-	B			-	N	)
+	0.00564		SIN (	A	-	G	+	B			+	N	)
+	0.00561		SIN (	2A			+	B					)
+	0.00490		SIN (	2A			-	B					)
+	0.00466		SIN (	A			+	B	+	2D	+	N	)
-	0.00456		SIN (					3B	-	2D	+	N	)
+	0.00449		SIN (	A			-	B	+	2D			)
-	0.00442		SIN (	2A			-	B	-	2D	-	N	)
-	0.00411		SIN (	A	+	G	+	B			+	N	)
-	0.00383		SIN (					B	+	D	+	N	)
-	0.00347		SIN (			G	-	B	+	2D			)
+	0.00345		SIN (	A			-	B			+	N	)
-	0.00339		SIN (			G	-	B	-	2D	-	N	)
-	0.00283		SIN (	A	+	G	+	B	-	2D			)
-	0.00262		SIN (	2A			+	B	-	2D			)
+	0.00246		SIN (	A			-	3B			-	N	)
+	0.00235		SIN (	A	-	G	-	B					)
-	0.00205		SIN (	A	+	G	-	B					)
+	0.00200		SIN (					B	-	D			)
-	0.00196		SIN (			G	-	B	+	2D	-	N	)
-	0.00194		SIN (					B	-	2D	-	N	)
+	0.00184		SIN (	A	-	G	+	B	-	2D	+	N	)
-	0.00159		SIN (			G	-	B					)
+	0.00157		SIN (			G	-	B	+	D	-	N	)
-	0.00149		SIN (	A	+	G	-	B	-	2D			)
-	0.00145		SIN (			G	+	B					)
+	0.00136		SIN (	A			+	B	-	D	+	N	)
-	0.00131		SIN (	A			+	B			-	N	)
+	0.00130		SIN (	3A			+	B			+	N	)
-	0.00121		SIN (	2A			-	B	-	4D	-	N	)
+	0.00107		SIN (	A	-	G	-	B	-	2D	-	N	)
-	0.00103	T	SIN (	A			-	B			-	N	)
-	0.00102		SIN (	A			-	B	-	4D	-	N	)
-	0.00101		SIN (	A			+	B	-	4D			)

MOON RHO

● RADII^2

	3649.33705						
-	395.13669	COS (	A				)
-	68.62152	COS (	A			- 2D	)
-	53.97626	COS (				2D	)
+	6.60763	COS (	2A			- 2D	)
-	5.37817	COS (	2A				)
-	3.83002	COS (		G		- 2D	)
-	2.74067	COS (	A	+ G		- 2D	)
-	2.45500	COS (	A	- G			)
+	2.07579	COS (				D	)
+	1.99463	COS (	A	+ G			)
-	1.67417	COS (	A			+ 2D	)
+	1.50534	COS (	A		- 2B		)
+	0.86170	COS (		G			)
+	0.63844	COS (		G		+ 2D	)
+	0.47999	COS (	A	- G		- 2D	)
-	0.36333	COS (	A			- 4D	)
-	0.31717	COS (		G		+ D	)
+	0.24454	COS (	2A	+ G		- 2D	)
+	0.22594	COS (	3A			- 2D	)
+	0.22383	COS (			2B	- 2D	)
-	0.19482	COS (		2G		- 2D	)
-	0.18815	COS (	2A			- 4D	)
+	0.17697	COS (	A		+ 2B	- 2D	)
-	0.16949	COS (	A			- D	)
-	0.16070	COS (	A	- G		+ 2D	)
-	0.14986	COS (	3A				)
-	0.12428	COS (	A	+ G		- 4D	)
-	0.12291	COS (	2A		- 2B		)
-	0.12291	COS (			2B		)
-	0.10243	COS (	A	+ 2G		- 2D	)
+	0.10225	COS (	A	+ G		+ 2D	)
+	0.10177	COS (	A		- 2B	+ 2D	)
-	0.09261	COS (	A			+ 4D	)
+	0.08119	COS (	A			- 3D	)
-	0.07369	COS (		G		- 4D	)
-	0.06652	COS (	2A	- G			)
-	0.06444	COS (				4D	)
+	0.06290	COS (	A			+ D	)
+	0.05491	COS (	2A	+ G			)

MOON PHI

● RADII

	6.32962	SIN (	A					)
-	2.47970	SIN (			2B		+ 2N	)
-	1.28658	SIN (	A			- 2D		)
-	1.07447	SIN (			2B		+ N	)
+	1.07142	SIN (					N	)
+	0.59616	SIN (				2D		)
-	0.20417	SIN (	A		- 2B		- 2N	)
-	0.18647	SIN (		G				)
-	0.11463	SIN (			2B			)
-	0.08724	SIN (	A				+ N	)
-	0.08724	SIN (	A		- 2B		- N	)
-	0.06846	SIN (	A		+ 2B		+ 2N	)
-	0.05697	SIN (	A	+ G		- 2D		)
-	0.05566	SIN (	2A			- 2D		)
-	0.04273	SIN (		G		- 2D		)
+	0.04221	SIN (	2A					)
+	0.04037	SIN (	A		+ 2B	- 2D	+ 2N	)
+	0.03983	SIN (			2B	- 2D	+ N	)
-	0.03983	SIN (				2D	+ N	)
+	0.03684	SIN (	A	- G				)
-	0.03487	SIN (				D		)
-	0.02952	SIN (	A		+ 2B		+ N	)

(SERIES CONTINUED ON FOLLOWING PAGE)

(SERIES CONTINUED FROM PRECEDING PAGE)

	● RADII										
-	0.02952		SIN (	A				- N			)
-	0.02527		SIN (	A	+ G						)
+	0.02077		SIN (			2B	- 2D	+ 2N			)
-	0.01567		SIN (			2B	- 2D				)
+	0.01506		SIN (	A		- 2B	- 2D	- 2N			)
+	0.01424		SIN (	A		- 2B					)
+	0.01410		SIN (	A		+ 2B	- 2D	+ N			)
+	0.01410		SIN (	A			- 2D	- N			)
+	0.01122		SIN (	A			+ 2D				)
+	0.00700		SIN (	A	- G		- 2D				)
+	0.00648		SIN (	A			- 2D	+ N			)
+	0.00648		SIN (	A		- 2B	- 2D	- N			)
-	0.00621		SIN (		G		+ 2D				)
+	0.00516		SIN (	A			- D				)
+	0.00504		SIN (		G		+ D				)
-	0.00491		SIN (			2B	+ 2D	+ 2N			)
-	0.00490		SIN (					2N			)
+	0.00413		SIN (		G	- 2B		- 2N			)
+	0.00390		SIN (		G	+ 2B		+ 2N			)
-	0.00350		SIN (	A					+16E	-18W	)
-	0.00317		SIN (	A		+ 2B					)
+	0.00312		SIN (	3A							)
-	0.00280		SIN (	2A		+ 2B		+ 2N			)
+	0.00279	T	SIN (			2B		+ 2N			)
-	0.00253		SIN (	A		- 2B	+ 2D				)
-	0.00247		SIN (	A			- 4D				)
-	0.00215		SIN (	3A			- 2D				)
-	0.00213		SIN (			2B	+ 2D	+ N			)
-	0.00213		SIN (				2D	- N			)
-	0.00210		SIN (		2G						)
-	0.00207		SIN (	A	+ 2G		- 2D				)
+	0.00201		SIN (		G	+ 2B	- 2D	+ N			)
+	0.00201		SIN (		G		- 2D	- N			)
+	0.00194		SIN (	2A		+ 2B	- 2D	+ 2N			)
+	0.00193		COS (	A					+16E	-18W	)
-	0.00190		SIN (		2G		- 2D				)
-	0.00175		SIN (	2A	+ G		- 2D				)
+	0.00171		SIN (	A	+ G	+ 2B	- 2D	+ 2N			)
-	0.00157		SIN (	2A			- 4D				)
+	0.00149		SIN (		G	+ 2B	- 2D	+ 2N			)
-	0.00122		SIN (	2A		+ 2B		+ N			)
-	0.00122		SIN (	2A				- N			)
+	0.00112		SIN (				4D				)
-	0.00110		SIN (			2B	- D	+ 2N			)
-	0.00109		SIN (	A		+ 2B	- 2D				)
-	0.00106		SIN (	2A				+ N			)
-	0.00106		SIN (	2A		- 2B		- N			)
+	0.00102		SIN (	A	- G		+ 2D				)
+	0.00100		SIN (	2A	- G						)
-	0.00100		SIN (	A	+ G		- 4D				)
-	0.00100		SIN (	A	- G	- 2B		- 2N			)

MERCURY THETA

	AU			Argument
	0.397930		SIN	(L)
+	0.150237		SIN	(K)
-	0.047338		SIN	(K - H)
+	0.042380		SIN	(F)
+	0.015282		SIN	(K + H)
+	0.013354		SIN	(H - F)
+	0.009999		SIN	(G - L)
+	0.004311		SIN	(H + F)
+	0.003334		SIN	(G + L)
+	0.002331		SIN	(K + 2H)
+	0.000822		SIN	(K - 2H)
+	0.000658		SIN	(2H + F)
+	0.000563		SIN	(K - 2F)
+	0.000422		SIN	(K + 3H)
-	0.000232		SIN	(2H - F)
-	0.000208	T	SIN	(L)
-	0.000177		SIN	(K + H - 2F)
+	0.000119		SIN	(3H + F)
+	0.000084		SIN	(K + 4H)
-	0.000079	T	SIN	(K)
-	0.000068		COS	(K)
+	0.000057		SIN	(K - H - 2F)
+	0.000056		SIN	(K - 3H)
+	0.000042		SIN	(2G + L)
+	0.000039		SIN	(L - N)
-	0.000030	T	SIN	(G - L)
+	0.000024		SIN	(4H + F)
+	0.000023		COS	(K - H)
+	0.000021	T	SIN	(K - H)
+	0.000017		SIN	(K + 5H)
-	0.000016		SIN	(3H - F)
+	0.000015		SIN	(K - N)
-	0.000014		SIN	(2G - L)
-	0.000013		COS	(2K - L)
-	0.000013		COS	(L)
-	0.000010		COS	(G - L - J)
-	0.000010	T	SIN	(G + L)

MERCURY RHO

	AU			Argument
	1.159768			
+	0.754886		COS	(K - L)
-	0.237857		COS	(K - H - L)
+	0.076786		COS	(K + H - L)
-	0.061297		COS	(H)
-	0.033490		COS	(G)
-	0.018968		COS	(K + G - L)
+	0.011714		COS	(K + 2H - L)
+	0.006324		COS	(K - G - L)
+	0.005977		COS	(K + G - H - L)
+	0.004132		COS	(K - 2H - L)
-	0.003130		COS	(2H)
+	0.002827		COS	(K - 2F - L)
+	0.002119		COS	(K + 3H - L)
-	0.001993		COS	(K - G - H - L)
-	0.001929		COS	(K + G + H - L)
-	0.000892		COS	(K + H - 2F - L)
+	0.000643		COS	(K - G + H - L)
+	0.000423		COS	(K + 4H - L)
+	0.000344		SIN	(K - L)
-	0.000314		COS	(3H)
-	0.000294		COS	(K + G + 2H - L)
+	0.000287		COS	(K - H - 2F - L)
+	0.000283		COS	(K - 3H - L)
-	0.000140		COS	(2G)

(SERIES CONTINUED ON FOLLOWING PAGE)

(SERIES CONTINUED FROM PRECEDING PAGE)

	AU										
-	0.000115		SIN (	K		- H		- L			)
-	0.000104		COS (	K	+ G	- 2H		- L			)
+	0.000098		COS (	K	- G	+ 2H		- L			)
+	0.000087	T	COS (		G						)
+	0.000087		COS (	K		+ 5H		- L			)
+	0.000080		COS (	K	- 2G			- L			)
-	0.000071		COS (	K	+ G		- 2F	- L			)
+	0.000063		SIN (	2K				- 2L			)
-	0.000053		COS (	K	+ G	+ 3H		- L			)
-	0.000051		SIN (		G					- J	)
+	0.000048	T	COS (	K	+ G			- L			)
-	0.000047		COS (			4H					)
+	0.000043		COS (	K		- 2H	- 2F	- L			)
+	0.000036		SIN (		2G				- 2V		)
+	0.000035		COS (	K	- G	- 2H		- L			)
+	0.000031		SIN (	K		+ H		- L			)
+	0.000031		COS (	K		- 4H		- L			)
+	0.000027		SIN (			H					)
+	0.000026		COS (	K	+ 2G			- L			)
-	0.000025		SIN (	2K		- H		- 2L			)
-	0.000025		COS (	K	- 2G	- H		- L			)
+	0.000024		COS (	K	- G		- 2F	- L			)
+	0.000022		COS (	K	+ G	+ H	- 2F	- L			)

MERCURY PHI

	AU									
	0.361903		SIN (	K				- L		)
-	0.114032		SIN (	K		- H		- L		)
-	0.041295		SIN (					2L		)
+	0.036812		SIN (	K		+ H		- L		)
+	0.032116		SIN (		G					)
-	0.015591		SIN (	K				+ L		)
-	0.009193		SIN (				F	+ L		)
-	0.009193		SIN (				F	- L		)
+	0.005616		SIN (	K		+ 2H		- L		)
+	0.004912		SIN (	K		- H		+ L		)
-	0.002897		SIN (			H	- F	+ L		)
-	0.002897		SIN (			H	- F	- L		)
+	0.001981		SIN (	K		- 2H		- L		)
-	0.001586		SIN (	K		+ H		+ L		)
+	0.001355		SIN (	K			- 2F	- L		)
-	0.001038		SIN (		G			- 2L		)
+	0.001016		SIN (	K		+ 3H		- L		)
-	0.000935		SIN (			H	+ F	+ L		)
-	0.000935		SIN (			H	+ F	- L		)
-	0.000428		SIN (	K		+ H	- 2F	- L		)
-	0.000346		SIN (		G			+ 2L		)
-	0.000242		SIN (	K		+ 2H		+ L		)
+	0.000203		SIN (	K		+ 4H		- L		)
-	0.000165		COS (	K				- L		)
-	0.000143		SIN (			2H	+ F	+ L		)
-	0.000143		SIN (			2H	+ F	- L		)
+	0.000138		SIN (	K		- H	- 2F	- L		)
+	0.000136		SIN (	K		- 3H		- L		)
-	0.000085		SIN (	K		- 2H		+ L		)
-	0.000080	T	SIN (		G					)
-	0.000079		SIN (						N	)
+	0.000068		SIN (		2G					)
-	0.000058		SIN (	K			- 2F	+ L		)
+	0.000055		COS (	K		- H		- L		)
+	0.000050		SIN (			2H	- F	+ L		)
+	0.000050		SIN (			2H	- F	- L		)
+	0.000046	T	SIN (					2L		)
-	0.000044		SIN (	K		+ 3H		+ L		)
+	0.000041		SIN (	K		+ 5H		- L		)

(SERIES CONTINUED ON FOLLOWING PAGE)

(SERIES CONTINUED FROM PRECEDING PAGE)

	AU													
-	0.000030		COS (	2K					- 2L					)
-	0.000030													
+	0.000030		SIN (					C	- L					)
-	0.000026		SIN (			3H	+ F		+ L					)
-	0.000026		SIN (			3H	+ F		- L					)
-	0.000025		COS (		G							- J		)
+	0.000024		SIN (		4G						- 8M	+ 3J		)
+	0.000021		SIN (	K		- 2H	- 2F		- L					)
-	0.000019		SIN (		G					- V				)
+	0.000018		SIN (	K		+ H	- 2F		+ L					)
+	0.000018	T	SIN (	K					+ L					)
+	0.000018	T	SIN (	K					- L					)
-	0.000017		COS (		2G					- 2V				)
-	0.000017		SIN (	K					- L				+ N	)
-	0.000015		COS (	K		+ H			- L					)
+	0.000015		SIN (	K		- 4H			- L					)
+	0.000014		SIN (	K					- L				- N	)
+	0.000012		COS (			H								)
+	0.000012		COS (	2K		- H			- 2L					)

VENUS THETA

	AU										
	0.397930		SIN (				L				)
+	0.287616		SIN (	W							)
+	0.039280		SIN (			R					)
+	0.009999		SIN (		G		- L				)
+	0.003334		SIN (		G		+ L				)
-	0.002942		SIN (	W				- V			)
+	0.000982		SIN (	W				+ V			)
-	0.000402		SIN (			R		- V			)
+	0.000252		SIN (	W		- 2R					)
-	0.000208	T	SIN (				L				)
-	0.000163	T	SIN (	W							)
+	0.000134		SIN (			R		+ V			)
-	0.000062		COS (	W							)
+	0.000042		SIN (		2G		+ L				)
+	0.000039		SIN (				L			- N	)
-	0.000030	T	SIN (		G		- L				)
+	0.000028		SIN (	W						- N	)
-	0.000017		COS (	2W			- L				)
-	0.000017		COS (				L				)
-	0.000014		SIN (		2G		- L				)
-	0.000014	T	SIN (	W				+ V			)
+	0.000014	T	SIN (	W				- V			)
-	0.000010		COS (		G		- L		- J		)
-	0.000010	T	SIN (		G		+ L				)

VENUS RHO

	AU										
	1.523667										
+	1.445164		COS (	W				- L			)
-	0.036312		COS (	W	+ G			- L			)
-	0.033490		COS (		G						)
-	0.014783		COS (	W				- L	- V		)
+	0.012106		COS (	W	- G			- L			)
-	0.007131		COS (						V		)
+	0.004932		COS (	W				- L	+ V		)
+	0.001268		COS (	W		- 2R		- L			)
+	0.000386		COS (	W	+ G			- L	- V		)
+	0.000310		SIN (	W				- L			)
+	0.000152		COS (	W	- 2G			- L			)
-	0.000140		COS (		2G						)
-	0.000124		COS (	W	+ G			- L	+ V		)
-	0.000124		COS (	W	- G			- L	- V		)
+	0.000094	T	COS (	W	+ G			- L			)
+	0.000087	T	COS (		G						)
+	0.000084		SIN (	2W				- 2L			)
-	0.000069	T	COS (	W				- L	+ V		)
+	0.000069	T	COS (	W				- L	- V		)
-	0.000061	T	COS (	W				- L			)
-	0.000051		SIN (		G					- J	)
+	0.000050		COS (	W	+ 2G			- L			)
-	0.000043	T									
-	0.000037		SIN (	W	+ G			- L		- J	)
+	0.000036		SIN (		2G				- 2V		)
+	0.000034		SIN (	W	+ 2G			- L	- 2V		)
-	0.000032		COS (	W	+ G	- 2R		- L			)
-	0.000031	T	COS (	W	- G			- L			)
+	0.000030		COS (	W				- L	+ 2V		)
+	0.000027		COS (	W	- G			- L	+ V		)
-	0.000025		SIN (	W	+ 3G			- L	- 3V		)
-	0.000025		SIN (	W	- 3G			- L	+ 3V		)
-	0.000022		COS (	W			+ C	- 2L			)
+	0.000022		COS (	W			- C				)
+	0.000022		COS (	W				- L	- 2V		)
+	0.000021		COS (	W	+ 2G			- L	- 2V		)
-	0.000021		COS (	W	- 2G			- L	+ 2V		)

VENUS PHI

	AU												
	0.692832		SIN (	W				- L					)
-	0.041295		SIN (					2L					)
+	0.032116		SIN (		G								)
-	0.029847		SIN (	W				+ L					)
-	0.008520		SIN (			R		+ L					)
-	0.008520		SIN (			R		- L					)
-	0.007087		SIN (	W				- L	- V				)
+	0.002364		SIN (	W				- L	+ V				)
-	0.001038		SIN (		G			- 2L					)
+	0.000608		SIN (	W		- 2R		- L					)
-	0.000346		SIN (		G			+ 2L					)
+	0.000305		SIN (	W				+ L	- V				)
-	0.000148		COS (	W				- L					)
-	0.000102		SIN (	W				+ L	+ V				)
+	0.000087		SIN (			R		+ L	- V				)
+	0.000087		SIN (			R		- L	- V				)
-	0.000080	T	SIN (		G								)
-	0.000079		SIN (									N	)
+	0.000068		SIN (		2G								)
+	0.000046	T	SIN (					2L					)
-	0.000040		COS (	2W				- 2L					)
-	0.000040												
+	0.000035	T	SIN (	W				+ L					)
-	0.000033	T	SIN (	W				- L	+ V				)
+	0.000033	T	SIN (	W				- L	- V				)
-	0.000032		SIN (	W				- L				+ N	)
+	0.000030		SIN (				C	- L					)
-	0.000029		SIN (			R		+ L	+ V				)
-	0.000029		SIN (			R		- L	+ V				)
-	0.000026		SIN (	W		- 2R		+ L					)
+	0.000025		SIN (	W				- L				- N	)
-	0.000025		COS (		G						- J		)
+	0.000024		SIN (		4G					- 8M	+ 3J		)
-	0.000019		SIN (		G				- V				)
-	0.000017		COS (		2G				- 2V				)
-	0.000016		COS (	W	+ 2G			- L	- 2V				)
-	0.000016		COS (	W	- 2G			- L	+ 2V				)
+	0.000014		SIN (	W				- L	+ 2V				)
+	0.000012		COS (	W	+ 3G			- L	- 3V				)
+	0.000012		COS (	W	- 3G			- L	+ 3V				)
+	0.000010		SIN (	W				- L	- 2V				)

MARS THETA

	AU										
	0.603602		SIN (	P							)
+	0.397930		SIN (				L				)
-	0.084850		SIN (	P				- M			)
+	0.044939		SIN (			X					)
+	0.028101		SIN (	P				+ M			)
+	0.009999		SIN (		G		- L				)
-	0.006317		SIN (			X		- M			)
+	0.003334		SIN (		G		+ L				)
+	0.002092		SIN (			X		+ M			)
+	0.001962		SIN (	P				+ 2M			)
+	0.000661		SIN (	P				- 2M			)
-	0.000326	T	SIN (	P							)
-	0.000208	T	SIN (				L				)
+	0.000162		SIN (	P				+ 3M			)
+	0.000152		SIN (	P		- 2X					)
+	0.000145		SIN (			X		+ 2M			)
-	0.000062		COS (	P							)
+	0.000059		SIN (	P						- N	)
+	0.000050		SIN (			X		- 2M			)
-	0.000043		COS (	P				- M	+ 2J		)
+	0.000042		SIN (		2G		+ L				)
+	0.000040		SIN (	P				- M	+ J		)
+	0.000039		SIN (				L			- N	)
-	0.000037		COS (	P				- 2M	+ 2J		)
-	0.000035	T	SIN (	P				- M			)
+	0.000034		COS (	P				- M	+ J		)
-	0.000030	T	SIN (		G		- L				)
-	0.000022		SIN (	P		- 2X		+ M			)
-	0.000021		COS (	P				+ M	- 2J		)
+	0.000021		SIN (	P				- 3M			)
+	0.000019		COS (	P	+ G			- 2M			)
+	0.000019		COS (	P	- G			+ 2M			)
-	0.000017		SIN (	P				+ M	- J		)
-	0.000016		COS (	2P			- L				)
-	0.000016		COS (				L				)
+	0.000015	T	SIN (	P				+ M			)
+	0.000015		COS (	P				+ M	- J		)
-	0.000014		SIN (		2G		- L				)
+	0.000012		SIN (			X		+ 3M			)
+	0.000010		COS (	P	+ G			- M			)
+	0.000010		COS (	P	- G			+ M			)
-	0.000010		COS (		G		- L		- J		)
-	0.000010		COS (	P	+ 2G			- 3M			)
-	0.000010		COS (	P	- 2G			+ 3M			)
-	0.000010	T	SIN (		G		+ L				)

MARS RHO

	AU							
	3.352333							
+	3.032879	COS (	P			- L		)
-	0.432759	COS (					M	)
-	0.426341	COS (	P			- L	- M	)
+	0.141198	COS (	P			- L	+ M	)
-	0.076207	COS (	P	+ G		- L		)
-	0.033490	COS (		G				)
+	0.025407	COS (	P	- G		- L		)
+	0.010676	COS (	P	+ G		- L	- M	)
-	0.010061	COS (					2M	)
+	0.009859	COS (	P			- L	+ 2M	)
-	0.003572	COS (	P	- G		- L	- M	)
-	0.003548	COS (	P	+ G		- L	+ M	)
+	0.003321	COS (	P			- L	- 2M	)
+	0.001219	COS (	P	- G		- L	+ M	)
+	0.000812	COS (	P			- L	+ 3M	)
+	0.000768	COS (	P		- 2X	- L		)

(SERIES CONTINUED ON FOLLOWING PAGE)

(SERIES CONTINUED FROM PRECEDING PAGE)

	AU											
-	0.000479		COS (							3M		)
-	0.000399	T	COS (	P				- L		- M		)
-	0.000385	T	COS (							M		)
+	0.000320		COS (	P	- 2G			- L				)
+	0.000313		SIN (	P				- L				)
-	0.000248		COS (	P	+ G			- L		+ 2M		)
+	0.000214		SIN (	P				- L		- M	+ 2J	)
-	0.000213		SIN (							2M	- 2J	)
+	0.000199		COS (	P				- L		- M	+ J	)
+	0.000197	T	COS (	P	+ G			- L				)
+	0.000187		SIN (	P				- L		- 2M	+ 2J	)
-	0.000173		SIN (	P				- L		- M	+ J	)
+	0.000172		COS (							M	- J	)
+	0.000150		SIN (							M	- J	)
+	0.000142	T	COS (	P				- L		+ M		)
-	0.000140		COS (		2G							)
-	0.000122		SIN (							M	- 2J	)
-	0.000120		COS (	P	+ G			- L		- 2M		)
+	0.000119		COS (	P	- G			- L		+ 2M		)
-	0.000111		COS (	P		- 2X		- L		+ M		)
+	0.000107		SIN (	P				- L		+ M	- 2J	)
+	0.000106		COS (	P	+ 2G			- L				)
'+	0.000104		COS (	P				- L		- 3M		)
-	0.000097		COS (							4M		)
-	0.000097		SIN (	P	+ G			- L		- 2M		)
-	0.000097		SIN (	P	- G			- L		+ 2M		)
+	0.000087	T	COS (		G							)
-	0.000085		COS (	P				- L		+ M	- J	)
+	0.000081		SIN (	2P				- 2L				)
-	0.000078		SIN (	P	+ G			- L			- J	)
-	0.000074		SIN (	P				- L		+ M	- J	)
-	0.000067		SIN (							M		)
-	0.000065	T	COS (	P	- G			- L				)
-	0.000057	T	COS (							2M		)
-	0.000055		SIN (	P	- 2G			- L	+ 2V			)
-	0.000052		SIN (	P	+ G			- L		- M		)
-	0.000052		SIN (	P	- G			- L		+ M		)
-	0.000051		SIN (		G						- J	)
+	0.000051		SIN (	P	+ 2G			- L		- 3M		)
+	0.000051		SIN (	P	- 2G			- L		+ 3M		)
+	0.000050		COS (	P				- L		+ 4M		)
-	0.000047		COS (	P			+ C	- 2L				)
+	0.000047		COS (	P			- C					)
+	0.000046		SIN (	P				- L		+ 2M	- 2J	)
-	0.000046		SIN (								2J	)
-	0.000045		COS (	P	- 2G			- L		- M		)
-	0.000044	T	COS (	P				- L				)
-	0.000042		COS (								J	)
-	0.000040		COS (	P				- L	+ V	- 3M		)
+	0.000040		COS (	P				- L	- V	+ 3M		)
+	0.000038		COS (	P		- 2X		- L		- M		)
+	0.000037		SIN (								J	)
+	0.000036		SIN (		2G				- 2V			)

MARS PHI

	AU											
-	0.958565		SIN (	P				- L				)
+	0.272086		SIN (							M		)
-	0.062639		SIN (	2P								)
-	0.041295		SIN (	P				+ L				)
+	0.024086		SIN (	P	+ G			- L				)
-	0.009748		SIN (	P		+ X						)
+	0.009748		SIN (	P		- X						)
+	0.008805		SIN (	2P						- M		)
-	0.008030		SIN (	P	- G			- L				)

(SERIES CONTINUED ON FOLLOWING PAGE)

(SERIES CONTINUED FROM PRECEDING PAGE)

	AU												
+	0.003134		SIN (							2M			)
-	0.002916		SIN (	2P						+ M			)
+	0.001371		SIN (	P		+ X				- M			)
-	0.001371		SIN (	P		- X				+ M			)
+	0.001038		SIN (	P	- G			+ L					)
-	0.000454		SIN (	P		+ X				+ M			)
+	0.000454		SIN (	P		- X				- M			)
-	0.000368		SIN (			2X							)
-	0.000346		SIN (	P	+ G			+ L					)
+	0.000339		SIN (							3M			)
+	0.000275	T	SIN (							M			)
-	0.000204		SIN (	2P						+ 2M			)
-	0.000154		COS (							M	- 2J		)
-	0.000150												
-	0.000136		SIN (							M	- J		)
-	0.000121		SIN (									N	)
+	0.000119		COS (							M	- J		)
-	0.000112		COS (							2M	- 2J		)
-	0.000101		SIN (	P	- 2G			- L					)
+	0.000093		COS (		G					- 2M			)
-	0.000077		COS (	P				- L					)
+	0.000072	T	SIN (	2P									)
-	0.000069		SIN (	2P						- 2M			)
-	0.000060	T	SIN (	P	+ G			- L					)
+	0.000053		SIN (			2X				- M			)
+	0.000050		COS (		G					- M			)
-	0.000049		COS (		2G					- 3M			)
+	0.000046	T	SIN (	P				+ L					)
-	0.000046	T	SIN (	P				- L					)
+	0.000044		SIN (	P				- L				- N	)
-	0.000038		SIN (						V	- 3M			)
-	0.000035		SIN (		G					- M			)
-	0.000035		SIN (	P				- L				+ N	)
-	0.000035		SIN (		G					- 2M			)
-	0.000033		SIN (	P	+ 2G			- L					)
-	0.000032		SIN (	P		+ X				+ 2M			)
+	0.000032		SIN (	P		- X				- 2M			)
-	0.000031		COS (		2G					- 4M			)
-	0.000025		COS (	P	+ G			- L			- J		)
+	0.000024		SIN (							4M			)
+	0.000020	T	SIN (	P	- G			- L					)
-	0.000018		SIN (			2X				+ M			)
-	0.000018		SIN (	2P		- 2X							)
-	0.000017		COS (	P	- 2G			- L	+ 2V				)
-	0.000017		SIN (	2P						+ 3M			)
+	0.000015		SIN (	P			+ C	- 2L					)
-	0.000015		SIN (	P			- C						)
-	0.000011		SIN (	P		+ X				- 2M			)
+	0.000011		SIN (	P		- X				+ 2M			)

JUPITER THETA

	AU									
	2.067889		SIN (	Q						)
+	0.397930		SIN (				L			)
-	0.150094		SIN (	Q				- J		)
-	0.108763		COS (					J		)
+	0.050332	T	COS (	Q						)
+	0.049985		SIN (	Q				+ J		)
+	0.025047		COS (	Q						)
+	0.009999		SIN (		G		- L			)
+	0.007889									
+	0.006005		SIN (					J		)
+	0.005489		COS (	Q				+ 2J	- 5S	)
+	0.005469		COS (	Q				- 2J	+ 5S	)
-	0.004214	T	COS (	Q				- J		)
+	0.003334		SIN (		G		+ L			)
-	0.002624		COS (					2J		)
-	0.002499		SIN (	Q				+ 2J	- 5S	)
+	0.002288		SIN (	Q				- 2J	+ 5S	)
-	0.002095		COS (	Q				- J		)
-	0.001729	T	SIN (	Q						)
+	0.001681		SIN (	Q				+ 2J		)
+	0.001403		SIN (	Q				- 2J	+ 2S	)
-	0.001191		SIN (	Q				- 3J	+ 5S	)
+	0.001035	T	COS (	Q				+ J		)
+	0.000764		SIN (	Q				- J	+ 2S	)
+	0.000695	T	SIN (					J		)
-	0.000615		SIN (	Q						)
-	0.000587		COS (	Q				- 2J	+ 2S	)
-	0.000565		SIN (	Q				+ J	- 2S	)
+	0.000520		COS (	Q				- J	+ S	)
+	0.000511		COS (	Q				+ J		)
+	0.000484	T	COS (					J		)
+	0.000483		SIN (	Q				- 2J		)
+	0.000467		COS (	Q				- 2J	+ 3S	)
-	0.000424		SIN (	Q				+ 2J	- 2S	)
-	0.000383	T	SIN (	Q				- J		)
+	0.000364		SIN (					3J	- 5S	)
-	0.000349		SIN (	Q				- 2J	+ 3S	)
-	0.000349	T	SIN (	Q				+ 2J	- 5S	)
+	0.000340		COS (	Q				+ 3J	- 5S	)
-	0.000296		SIN (					J	- 5S	)
+	0.000284		COS (	Q				- J	+ 5S	)
+	0.000278		SIN (	Q				+ 3J	- 5S	)
+	0.000271		COS (	Q				+ J	- S	)
-	0.000208	T	SIN (				L			)
+	0.000201		SIN (	Q		- N				)
+	0.000193		COS (	Q				+ 2J	- 3S	)
-	0.000168		COS (	Q				+ 2J	- 2S	)
-	0.000161	T	COS (	Q				+ 2J	- 5S	)
+	0.000151		COS (					3J	- 5S	)
+	0.000145		SIN (	Q				+ 2J	- 3S	)
+	0.000136		SIN (					2J		)
+	0.000135	T	SIN (	Q				+ J		)
+	0.000126		SIN (	3Q						)
+	0.000121		SIN (	Q				- J	+ 5S	)
+	0.000113		COS (	Q				- 3J	+ 3S	)
-	0.000108		COS (					J	- 5S	)

JUPITER RHO

	AU							
	28.163503							
+	10.389747		COS (	Q		- L		)
-	2.615916		COS (				J	)
-	0.754092		COS (	Q		- L	- J	)
-	0.261061		COS (	Q	+ G	- L		)
-	0.252992	T	SIN (	Q		- L		)

(SERIES CONTINUED ON FOLLOWING PAGE)

(SERIES CONTINUED FROM PRECEDING PAGE)

	AU			
+	0.251110		COS	(Q - L + J)
-	0.127118		SIN	(Q - L)
+	0.087037		COS	(Q - G - L)
-	0.033490		COS	(G)
-	0.031175		COS	(2J)
-	0.027578		SIN	(Q - L + 2J - 5S)
-	0.027479		SIN	(Q - L - 2J + 5S)
+	0.027112		COS	(2J - 2S)
+	0.021175	T	SIN	(Q - L - J)
+	0.018948		COS	(Q + G - L - J)
-	0.017677		COS	(3J - 5S)
-	0.012556		COS	(Q - L + 2J - 5S)
+	0.011496		COS	(Q - L - 2J + 5S)
-	0.011382		SIN	(2J - 2S)
+	0.010554		SIN	(Q - L - J)
-	0.009853	T	SIN	(J)
-	0.009062	T	COS	(J)
+	0.008450		COS	(Q - L + 2J)
+	0.007176		SIN	(2J - 3S)
+	0.007047		COS	(Q - L - 2J + 2S)
+	0.006790		SIN	(3J - 5S)
+	0.006481		SIN	(J - S)
-	0.006416		SIN	(J - 5S)
+	0.006357	T	SIN	(Q + G - L)
-	0.006317		COS	(Q - G - L - J)
-	0.006310		COS	(Q + G - L + J)
-	0.005986		COS	(Q - L - 3J + 5S)
-	0.005328		COS	(2J - 3S)
-	0.005198	T	SIN	(Q - L + J)
-	0.004804		SIN	(J)
+	0.003837		COS	(Q - L - J + 2S)
-	0.003217	T	COS	(Q - L)
+	0.003168		SIN	(Q + G - L)
-	0.003088		COS	(Q - L)
+	0.002949		SIN	(Q - L - 2J + 2S)
-	0.002839		COS	(Q - L + J - 2S)
+	0.002827		SIN	(3J - 3S)
-	0.002750		COS	(J - 5S)
-	0.002611		SIN	(Q - L - J + S)
-	0.002587		SIN	(Q - L + J)
+	0.002527		COS	(J - 2S)
+	0.002424		COS	(Q - L - 2J)
-	0.002348		SIN	(Q - L - 2J + 3S)
-	0.002268	T	COS	(Q - L - J)
-	0.002129		COS	(Q - L + 2J - 2S)
-	0.002119	T	SIN	(Q - G - L)
+	0.002104		COS	(Q - G - L + J)
-	0.002040		SIN	(2J - 5S)
-	0.001803		COS	(2S)
-	0.001756		COS	(Q - L - 2J + 3S)
-	0.001756	T	COS	(Q - L + 2J - 5S)
-	0.001708		SIN	(Q - L + 3J - 5S)
-	0.001426		SIN	(Q - L - J + 5S)
+	0.001395		COS	(Q - L + 3J - 5S)
-	0.001363		SIN	(Q - L + J - S)
+	0.001284		COS	(3J - 3S)
+	0.001112		SIN	(J - 2S)
+	0.001095		COS	(Q - 2G - L)
-	0.001056		SIN	(Q - G - L)
+	0.000985		SIN	(S)
-	0.000968		SIN	(Q - L + 2J - 3S)
-	0.000886		SIN	(J - 3S)
-	0.000845	T	SIN	(J - 2S)
+	0.000844		SIN	(Q - L + 2J - 2S)
+	0.000842		SIN	(2J - S)
+	0.000808	T	SIN	(Q - L + 2J - 5S)
+	0.000787	T	COS	(Q - L + J)
+	0.000731		COS	(Q - L + 2J - 3S)
-	0.000696		COS	(Q + L)
+	0.000693		SIN	(Q + G - L + 2J - 5S)

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(SERIES CONTINUED FROM PRECEDING PAGE)

	AU									
+	0.000690		SIN (	Q	+ G		- L	- 2J	+ 5S	)
-	0.000689		SIN (					3J	- 2S	)
+	0.000666		COS (	2Q				- J		)
+	0.000662		COS (					J	- 3S	)
+	0.000662	T	COS (					3J	- 5S	)
+	0.000662	T	COS (	Q	+ G		- L			)
+	0.000645		COS (					4J	- 5S	)
+	0.000634		COS (	3Q			- L			)
+	0.000609		COS (	Q			- L	- J	+ 5S	)
-	0.000599	T	COS (					2J		)
+	0.000593		SIN (					4J	- 5S	)
+	0.000569	T	SIN (					2J		)
-	0.000567		SIN (	Q			- L	- 3J	+ 3S	)
-	0.000532	T	SIN (	Q	+ G		- L	- J		)
+	0.000495		SIN (						5S	)
-	0.000472		SIN (	Q				- J	+ 5S	)
+	0.000453	T	SIN (					3J	- 5S	)
-	0.000435		SIN (	2Q				- 2J		)
+	0.000432		COS (	Q		- N	- L			)
-	0.000429		SIN (	Q			- L	+ 2J	- 4S	)
-	0.000429		SIN (	Q			- L	- 2J	+ 4S	)
+	0.000424	T	COS (	Q			- L	- 2J	+ 5S	)
-	0.000421		COS (		2G					)
-	0.000373	T	COS (					2J	- 2S	)
-	0.000365		COS (	Q			- L	+ J	- S	)
+	0.000365		COS (	Q			- L	- J	+ S	)
-	0.000359		COS (	Q		+ N	- L			)
-	0.000340		COS (	Q			- L	+ 3J	- 4S	)
+	0.000340		COS (	Q			- L	- 3J	+ 4S	)
+	0.000330	T	COS (					J	- S	)
-	0.000327		COS (	2Q				+ J		)
+	0.000315		COS (	Q	+ G		- L	+ 2J	- 5S	)
+	0.000311		COS (	Q			- L	+ 3J		)
-	0.000310		SIN (	Q				- J	+ 2S	)
+	0.000300		COS (	Q			- L	- 3J	+ 3S	)
+	0.000297	T	COS (					2J	- 3S	)
-	0.000289		COS (	Q	+ G		- L	- 2J	+ 5S	)

JUPITER PHI

	AU									
-	0.958565		SIN (	Q			- L			)
+	0.481906		SIN (					J		)
-	0.213974		SIN (	2Q						)
+	0.121291	T								
+	0.060452									
-	0.041295		SIN (	Q			+ L			)
+	0.026395		COS (					2J	- 5S	)
+	0.024086		SIN (	Q	+ G		- L			)
+	0.023592		COS (	Q				+ J		)
+	0.023592		COS (	Q				- J		)
+	0.015537		SIN (	2Q				- J		)
-	0.011531		SIN (					2J	- 5S	)
-	0.008030		SIN (	Q	- G		- L			)
-	0.007660	T	COS (					J		)
-	0.005240	T	COS (	2Q						)
-	0.005164		SIN (	2Q				+ J		)
-	0.004399		SIN (					2J	- 2S	)
-	0.003820		COS (					J		)
+	0.003539		SIN (					3J	- 5S	)
-	0.003422		COS (	Q						)
-	0.003200		SIN (					J	- 2S	)
+	0.002889		SIN (					2J		)
-	0.002829		COS (	2Q						)
+	0.001905		COS (					J	- S	)
-	0.001819		COS (					2J	- 2S	)

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(SERIES CONTINUED FROM PRECEDING PAGE)

	AU										
+	0.001590		COS (						2J	- 3S	)
+	0.001499	T	SIN (						J		)
-	0.001304		SIN (	Q					+ J		)
+	0.001304		SIN (	Q					- J		)
+	0.001192		SIN (						2J	- 3S	)
-	0.001045	T	SIN (						2J	- 5S	)
+	0.001038		SIN (	Q	- G			+ L			)
+	0.000951		COS (						3J	- 5S	)
+	0.000684		COS (						J	- 5S	)
+	0.000571		COS (	Q					+ 2J		)
+	0.000571		COS (	Q					- 2J		)
-	0.000570		COS (	2Q					+ 2J	- 5S	)
-	0.000568		COS (	2Q					- 2J	+ 5S	)
-	0.000480	T	COS (						2J	- 5S	)
+	0.000437	T	COS (	2Q					- J		)
-	0.000412		SIN (				N				)
+	0.000411		COS (						2J	- 4S	)
-	0.000350		SIN (						J	- S	)
-	0.000346		SIN (	Q	+ G			+ L			)
+	0.000343		COS (						3J	- 3S	)
-	0.000326		SIN (						3J	- 4S	)
+	0.000303	T	SIN (	2Q							)
-	0.000292		SIN (						J	- 5S	)
+	0.000259		SIN (	2Q					+ 2J	- 5S	)
-	0.000237		SIN (	2Q					- 2J	+ 5S	)
+	0.000231		COS (	2Q					- J		)
-	0.000217		SIN (							S	)
+	0.000212		COS (							S	)
+	0.000208		SIN (			3U			+ 2J	- 6S	)
-	0.000199		COS (						4J	-10S	)
-	0.000195		SIN (						J	- 3S	)
+	0.000180		COS (						3J	- 4S	)
-	0.000177		SIN (						4J	-10S	)
-	0.000176		COS (						J	- 3S	)
-	0.000176		SIN (	2Q					+ 2J		)
+	0.000167	T	COS (						2J		)
-	0.000150	T	SIN (	Q					+ J		)
+	0.000150	T	SIN (	Q					- J		)
-	0.000145		SIN (	2Q					- 2J	+ 2S	)
-	0.000144		SIN (						3J	- 3S	)
+	0.000137		COS (							2S	)
+	0.000124		SIN (	2Q					- 3J	+ 5S	)
-	0.000120	T	COS (	Q					+ J		)
-	0.000120	T	COS (	Q					- J		)
-	0.000107	T	COS (	2Q					+ J		)
-	0.000107		SIN (						J		)
-	0.000101		SIN (	Q	- 2G			- L			)

Section F: STELLAR TABLES

STAR POSITIONS FOR YEAR 1978

DAYS 1 THRU 365 JD 2443509.5 TO 2443874.5 DATES JAN 1 THRU DEC 31

A = 365.00000000 B = -0.00273973

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
1	1	ALPHA AND	2.1	SHA	358.1883	-0.0022	-0.0115	0.0059	0.0009	358.1795
		ALPHERATZ	A0	DEC	28.9689	0.0003	0.0049	-0.0024	0.0024	28.9692
2		BETA CAS	2.4	SHA	358.0013	-0.0050	-0.0119	0.0100	0.0014	357.9889
		CAPH	F5	DEC	59.0286	0.0003	0.0049	-0.0019	0.0046	59.0267
3		GAMMA PEG	2.9	SHA	356.9750	-0.0015	-0.0115	0.0054	0.0007	356.9671
		ALGENIB	B2	DEC	15.0614	0.0002	0.0049	-0.0023	0.0011	15.0630
4		BETA HYI	2.9	SHA	353.8463	0.0105	-0.0083	0.0239	0.0015	353.8511
			G0	DEC	-77.3781	0.0001	0.0049	-0.0000	-0.0056	-77.3699
5	2	ALPHA PHE	2.4	SHA	353.7004	0.0015	-0.0107	0.0071	0.0004	353.6962
		ANKAA	K0	DEC	-42.4256	0.0001	0.0049	-0.0013	-0.0041	-42.4189
6	3	ALPHA CAS	2.3	SHA	350.1879	-0.0046	-0.0129	0.0095	-0.0001	350.1769
		SCHEDAR	K0	DEC	56.4169	-0.0001	0.0048	-0.0013	0.0045	56.4148
7	4	BETA CET	2.2	SHA	349.3788	0.0000	-0.0110	0.0055	-0.0001	349.3734
		DIPHDA	K0	DEC	-18.1072	-0.0001	0.0048	-0.0021	-0.0021	-18.1028
8		GAMMA CAS	2-3	SHA	346.1579	-0.0053	-0.0137	0.0107	-0.0009	346.1467
			B0	DEC	60.5981	-0.0003	0.0048	-0.0009	0.0047	60.5954
9		BETA AND	2.4	SHA	342.8763	-0.0026	-0.0125	0.0064	-0.0009	342.8683
		MIRACH	M0	DEC	35.5042	-0.0004	0.0047	-0.0015	0.0029	35.5032
10		DELTA CAS	2.8	SHA	338.9092	-0.0051	-0.0147	0.0104	-0.0023	338.8990
		RUCHBAH	A5	DEC	60.1214	-0.0006	0.0045	-0.0003	0.0046	60.1185
11	5	ALPHA ERI	0.6	SHA	335.7762	0.0030	-0.0080	0.0095	-0.0027	335.7779
		ACHERNAR	B5	DEC	-57.3483	-0.0007	0.0044	-0.0022	-0.0048	-57.3420
12		BETA ARI	2.7	SHA	331.6450	-0.0017	-0.0123	0.0054	-0.0020	331.6391
		SHERATAN	A5	DEC	20.7011	-0.0009	0.0043	-0.0015	0.0015	20.7008
13		ALPHA HYI	3.0	SHA	330.4808	0.0036	-0.0066	0.0105	-0.0041	330.4852
			F0	DEC	-61.6764	-0.0009	0.0042	-0.0025	-0.0049	-61.6703
14		GAMMA-1 AND	2.3	SHA	329.3646	-0.0029	-0.0138	0.0067	-0.0028	329.3575
		ALMAK	K0	DEC	42.2247	-0.0010	0.0042	-0.0005	0.0033	42.2226
15	6	ALPHA ARI	2.2	SHA	328.5179	-0.0018	-0.0125	0.0054	-0.0023	328.5122
		HAMAL	K2	DEC	23.3589	-0.0010	0.0041	-0.0013	0.0017	23.3582
16		BETA TRI	3.1	SHA	327.9429	-0.0024	-0.0133	0.0060	-0.0027	327.9365
			A5	DEC	34.8839	-0.0010	0.0041	-0.0008	0.0027	34.8822
17		ALPHA UMI	2.1	SHA	327.4950	-0.1591	-0.2022	0.3346	-0.1524	327.3872
		POLARIS	F8	DEC	89.1642	-0.0011	0.0041	0.0019	0.0052	89.1599
18	7	THETA ERI	3.4	SHA	315.6433	0.0009	-0.0083	0.0058	-0.0043	315.6444
		ACAMAR	A2	DEC	-40.3922	-0.0015	0.0034	-0.0036	-0.0033	-40.3887
19	8	ALPHA CET	2.8	SHA	314.7183	-0.0009	-0.0116	0.0043	-0.0033	314.7149
		MENKAR	M0	DEC	4.0042	-0.0015	0.0034	-0.0020	-0.0001	4.0044
20		BETA PER	2-3	SHA	313.3171	-0.0025	-0.0145	0.0056	-0.0045	313.3118
		ALGOL	B8	DEC	40.8719	-0.0016	0.0033	0.0003	0.0027	40.8693

F2

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0 '	0	0	0	0
21	9	ALPHA PER	1.9	SHA	309.3142	-0.0030	-0.0160	0.0063	-0.0058	309.3090
		MIRFAK	F5	DEC	49.7842	-0.0017	0.0030	0.0011	0.0030	49.7809
22		ETA TAU	3.0	SHA	303.4567	-0.0016	-0.0132	0.0040	-0.0046	303.4531
		ALCYONE	B5	DEC	24.0381	-0.0019	0.0026	-0.0005	0.0012	24.0362
23		ZETA PER	2.9	SHA	301.8138	-0.0018	-0.0140	0.0042	-0.0050	301.8100
			B1	DEC	31.8194	-0.0020	0.0025	0.0001	0.0016	31.8171
24		EPSILON PER	3.0	SHA	300.9C67	-0.0021	-0.0150	0.0046	-0.0056	300.9027
			B1	DEC	39.9478	-0.0020	0.0024	0.0008	0.0021	39.9449
25		GAMMA ERI	3.2	SHA	300.7496	-0.0004	-0.0103	0.0036	-0.0045	300.7485
			K5	DEC	-13.5703	-0.0020	0.0024	-0.0031	-0.0013	-13.5698
26	10	ALPHA TAU	1.1	SHA	291.3358	-0.0012	-0.0127	0.0029	-0.0051	291.3334
		ALDEBARAN	K5	DEC	16.4661	-0.0022	0.0016	-0.0009	0.0004	16.4643
27		IOTA AUR	2.9	SHA	286.1104	-0.0015	-0.0145	0.0029	-0.0061	286.1078
			K2	DEC	33.1325	-0.0023	0.0012	0.0007	0.0010	33.1298
28		BETA ERI	2.9	SHA	283.3083	-0.0007	-0.0109	0.0022	-0.0053	283.3074
			A3	DEC	-5.1139	-0.0024	0.0010	-0.0026	-0.0006	-5.1152
29	11	BETA ORI	0.3	SHA	281.6300	-0.0007	-0.0106	0.0021	-0.0054	281.6293
		RIGEL	B8	DEC	-8.2261	-0.0024	0.0008	-0.0029	-0.0007	-8.2274
30	12	ALPHA AUR	0.2	SHA	281.2346	-0.0017	-0.0164	0.0029	-0.0076	281.2324
		CAPELLA	G0	DEC	45.9772	-0.0024	0.0008	0.0019	0.0012	45.9741
31	13	GAMMA ORI	1.7	SHA	279.0125	-0.0009	-0.0119	0.0018	-0.0054	279.0111
		BELLATRIX	B2	DEC	6.3308	-0.0024	0.0006	-0.0017	-0.0002	6.3289
32	14	BETA TAU	1.8	SHA	278.7750	-0.0012	-0.0140	0.0020	-0.0061	278.7729
		ELNATH	B8	DEC	28.5903	-0.0024	0.0006	0.0004	0.0005	28.5876
33		BETA LEP	3.0	SHA	278.1746	-0.0005	-0.0095	0.0019	-0.0058	278.1751
			G0	DEC	-20.7761	-0.0024	0.0005	-0.0038	-0.0010	-20.7773
34		DELTA ORI	2.5	SHA	277.2796	-0.0008	-0.0113	0.0017	-0.0054	277.2786
			B0	DEC	-0.3144	-0.0025	0.0005	-0.0023	-0.0004	-0.3162
35		ALPHA LEP	2.7	SHA	277.0604	-0.0006	-0.0098	0.0017	-0.0057	277.0607
			F0	DEC	-17.8369	-0.0025	0.0004	-0.0036	-0.0009	-17.8383
36		IOTA ORI	2.9	SHA	276.4108	-0.0007	-0.0108	0.0016	-0.0055	276.4102
			05	DEC	-5.9233	-0.0025	0.0004	-0.0027	-0.0006	-5.9250
37	15	EPSILON ORI	1.7	SHA	276.2258	-0.0008	-0.0112	0.0016	-0.0055	276.2249
		ALNILAM	B0	DEC	-1.2150	-0.0025	0.0004	-0.0023	-0.0004	-1.2168
38		ZETA TAU	3.0	SHA	275.9179	-0.0010	-0.0133	0.0017	-0.0059	275.9161
			B3	DEC	21.1303	-0.0025	0.0004	-0.0003	0.0002	21.1278
39		ALPHA COL	2.7	SHA	275.2871	-0.0004	-0.0080	0.0018	-0.0066	275.2893
		PHACT	B5	DEC	-34.0850	-0.0025	0.0003	-0.0047	-0.0011	-34.0862
40		ZETA ORI	2.0	SHA	275.0879	-0.0008	-0.0112	0.0015	-0.0055	275.0870
		ALNITAK	B0	DEC	-1.9533	-0.0025	0.0003	-0.0024	-0.0005	-1.9552
41		KAPPA ORI	2.2	SHA	273.3221	-0.0007	-0.0105	0.0013	-0.0056	273.3217
			B0	DEC	-9.6764	-0.0025	0.0001	-0.0030	-0.0006	-9.6782
42	16	ALPHA ORI	0-1	SHA	271.5050	-0.0009	-0.0120	0.0012	-0.0056	271.5038
		BETELGEUSE	M0	DEC	7.4042	-0.0025	-0.0000	-0.0016	-0.0003	7.4019
43		BETA AUR	2.1	SHA	270.5213	-0.0012	-0.0163	0.0015	-0.0079	270.5198
		MENKALINAN	A0	DEC	44.9467	-0.0025	-0.0001	0.0020	0.0004	44.9437

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					o	o	o	o	o	o
44		THETA AUR	2.7	SHA	270.4450	-0.0011	-0.0151	0.0013	-0.0070	270.4434
			A0	DEC	37.2122	-0.0025	-0.0001	0.0013	0.0003	37.2094
45		BETA CMA	2.0	SHA	264.5675	-0.0008	-0.0098	0.0006	-0.0060	264.5678
		MIRZAM	B1	DEC	-17.9442	-0.0025	-0.0006	-0.0037	-0.0005	-17.9465
46	17	ALPHA CAR	-0.9	SHA	264.1342	-0.0007	-0.0049	0.0008	-0.0093	264.1404
		CANOPUS	F0	DEC	-52.6833	-0.0025	-0.0007	-0.0055	-0.0005	-52.6857
47		GAMMA GEM	1.9	SHA	260.8896	-0.0008	-0.0128	0.0002	-0.0059	260.8883
		ALHENA	A0	DEC	16.4192	-0.0025	-0.0009	-0.0007	-0.0004	16.4165
48	18	ALPHA CMA A	-1.6	SHA	258.9563	-0.0008	-0.0099	0.0000	-0.0059	258.9564
		SIRIUS	A0	DEC	-16.6856	-0.0025	-0.0011	-0.0036	-0.0003	-16.6883
49		TAU PUP	2.8	SHA	257.6529	-0.0010	-0.0055	-0.0002	-0.0089	257.6580
			K0	DEC	-50.5881	-0.0025	-0.0012	-0.0055	-0.0000	-50.5912
50	19	EPSILON CMA	1.6	SHA	255.5596	-0.0010	-0.0087	-0.0003	-0.0065	255.5607
		ADHARA	B1	DEC	-28.9414	-0.0025	-0.0014	-0.0045	-0.0001	-28.9445
51		OMICRON-2 CMA	3.1	SHA	254.4738	-0.0010	-0.0093	-0.0004	-0.0062	254.4743
			B5	DEC	-23.8003	-0.0025	-0.0015	-0.0041	-0.0001	-23.8034
52		DELTA CMA	2.0	SHA	253.1258	-0.0010	-0.0090	-0.0006	-0.0063	253.1266
		WEZEN	F8	DEC	-26.3575	-0.0025	-0.0016	-0.0043	-0.0000	-26.3608
53		PI PUP	2.7	SHA	250.9083	-0.0012	-0.0079	-0.0009	-0.0070	250.9102
			K5	DEC	-37.0572	-0.0025	-0.0018	-0.0049	0.0002	-37.0608
54		ETA CMA	2.4	SHA	249.1938	-0.0011	-0.0088	-0.0010	-0.0064	249.1946
			B5	DEC	-29.2594	-0.0025	-0.0019	-0.0045	0.0002	-29.2631
55		BETA CMI	3.1	SHA	248.5104	-0.0007	-0.0120	-0.0009	-0.0056	248.5093
			B8	DEC	8.3347	-0.0025	-0.0020	-0.0015	-0.0006	8.3318
56		SIGMA PUP	3.3	SHA	247.8671	-0.0014	-0.0071	-0.0014	-0.0076	247.8697
			K5	DEC	-43.2564	-0.0025	-0.0020	-0.0051	0.0006	-43.2604
57		ALPHA GEM A	2.0	SHA	246.7013	-0.0004	-0.0141	-0.0013	-0.0065	246.7003
		CASTOR	A0	DEC	31.9378	-0.0024	-0.0021	0.0008	-0.0011	31.9353
58		ALPHA GEM B	2.8	SHA	246.7004	-0.0004	-0.0141	-0.0013	-0.0065	246.6995
			A0	DEC	31.9378	-0.0024	-0.0021	0.0008	-0.0011	31.9353
59	20	ALPHA CMI A	0.5	SHA	245.4625	-0.0007	-0.0118	-0.0012	-0.0055	245.4614
		PROCYON	F5	DEC	5.2822	-0.0024	-0.0022	-0.0017	-0.0005	5.2792
60	21	BETA GEM	1.2	SHA	244.0071	-0.0004	-0.0137	-0.0015	-0.0062	244.0060
		POLLUX	K0	DEC	28.0806	-0.0024	-0.0023	0.0004	-0.0011	28.0781
61		ZETA PUP	2.3	SHA	239.2975	-0.0016	-0.0079	-0.0023	-0.0069	239.2988
			O	DEC	-39.9406	-0.0023	-0.0027	-0.0049	0.0010	-39.9452
62		RHO PUP	2.9	SHA	238.3483	-0.0013	-0.0095	-0.0020	-0.0058	238.3481
			F5	DEC	-24.2400	-0.0023	-0.0027	-0.0040	0.0005	-24.2442
63		GAMMA-2 VEL	1.9	SHA	237.7867	-0.0019	-0.0069	-0.0028	-0.0077	237.7890
			O	DEC	-47.2711	-0.0023	-0.0028	-0.0051	0.0013	-47.2761
64	22	EPSILON CAR	1.7	SHA	234.4842	-0.0028	-0.0047	-0.0042	-0.0100	234.4891
		AVIOR	*	DEC	-59.4383	-0.0023	-0.0030	-0.0052	0.0019	-59.4440
65		DELTA VEL	2.0	SHA	228.9758	-0.0028	-0.0063	-0.0045	-0.0084	228.9783
			A0	DEC	-54.6275	-0.0021	-0.0034	-0.0050	0.0022	-54.6335
66		IOTA UMA	3.1	SHA	225.5729	0.0009	-0.0152	-0.0043	-0.0070	225.5732
			A5	DEC	48.1289	-0.0020	-0.0036	0.0018	-0.0027	48.1278

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
67	23	LAMBDA VEL	2.2	SHA	223.2038	-0.0023	-0.0083	-0.0042	-0.0062	223.2035
		SUHAIL	K5	DEC	-43.3433	-0.0020	-0.0037	-0.0045	0.0021	-43.3492
68	24	BETA CAR	1.8	SHA	221.7583	-0.0052	-0.0028	-0.0091	-0.0127	221.7644
		MIAPLACIDUS	A0	DEC	-69.6267	-0.0019	-0.0038	-0.0047	0.0032	-69.6337
69		IOTA CAR	2.2	SHA	220.8746	-0.0036	-0.0061	-0.0063	-0.0085	220.8764
			F0	DEC	-59.1828	-0.0019	-0.0038	-0.0047	0.0029	-59.1895
70		KAPPA VEL	2.6	SHA	219.6421	-0.0032	-0.0070	-0.0058	-0.0075	219.6428
			B3	DEC	-54.9164	-0.0019	-0.0039	-0.0046	0.0028	-54.9230
71	25	ALPHA HYA	2.2	SHA	218.3733	-0.0011	-0.0109	-0.0034	-0.0043	218.3711
		ALPHARD	K2	DEC	-8.5625	-0.0018	-0.0040	-0.0028	0.0002	-8.5665
72		N VEL	3.0	SHA	217.3621	-0.0036	-0.0069	-0.0064	-0.0076	217.3627
			K5	DEC	-56.9369	-0.0018	-0.0040	-0.0045	0.0030	-56.9438
73		EPSILON LEO	3.1	SHA	213.8488	0.0000	-0.0125	-0.0040	-0.0043	213.8468
			G0	DEC	23.8761	-0.0017	-0.0042	-0.0005	-0.0020	23.8744
74	26	ALPHA LEO	1.3	SHA	208.1996	-0.0004	-0.0118	-0.0041	-0.0035	208.1969
		REGULUS	B8	DEC	12.0753	-0.0015	-0.0044	-0.0015	-0.0013	12.0729
75		GAMMA-1 LEO	2.6	SHA	205.3096	-0.0000	-0.0121	-0.0045	-0.0034	205.3070
		ALGEIBA	K0	DEC	19.9533	-0.0014	-0.0045	-0.0010	-0.0020	19.9517
76		THETA CAR	3.0	SHA	199.4579	-0.0055	-0.0082	-0.0104	-0.0063	199.4546
			B0	DEC	-64.2789	-0.0012	-0.0047	-0.0034	0.0043	-64.2867
77		MU VEL	2.8	SHA	198.5454	-0.0034	-0.0097	-0.0070	-0.0041	198.5412
			G5	DEC	-49.3036	-0.0011	-0.0047	-0.0034	0.0035	-49.3106
78		BETA UMA	2.4	SHA	194.8692	0.0027	-0.0130	-0.0085	-0.0042	194.8696
		MERAK	A0	DEC	56.5006	-0.0010	-0.0048	0.0007	-0.0045	56.5017
79	27	ALPHA UMA	1.9	SHA	194.4046	0.0036	-0.0134	-0.0100	-0.0049	194.4064
		DUBHE	K0	DEC	61.8700	-0.0010	-0.0048	0.0009	-0.0048	61.8714
80		PSI UMA	3.1	SHA	192.8921	0.0015	-0.0123	-0.0067	-0.0030	192.8905
			K0	DEC	44.6181	-0.0009	-0.0048	-0.0001	-0.0040	44.6187
81		DELTA LEO	2.6	SHA	191.7650	0.0001	-0.0117	-0.0052	-0.0022	191.7615
			A3	DEC	20.6444	-0.0009	-0.0049	-0.0014	-0.0022	20.6434
82	28	BETA LEO	2.2	SHA	183.0154	-0.0002	-0.0114	-0.0053	-0.0013	183.0108
		DENEBOLA	A2	DEC	14.6950	-0.0005	-0.0049	-0.0018	-0.0018	14.6938
83		GAMMA UMA	2.5	SHA	181.8304	0.0026	-0.0113	-0.0086	-0.0019	181.8292
		PHECDA	A0	DEC	53.8169	-0.0004	-0.0049	-0.0004	-0.0047	53.8188
84		DELTA CEN	2.9	SHA	178.1971	-0.0039	-0.0117	-0.0081	-0.0012	178.1885
			B3	DEC	-50.6000	-0.0003	-0.0049	-0.0021	0.0041	-50.6068
85	29	GAMMA CRV	2.8	SHA	176.3321	-0.0016	-0.0115	-0.0054	-0.0006	176.3253
		GIENAH	B8	DEC	-17.4200	-0.0002	-0.0049	-0.0023	0.0013	-17.4239
86	30	ALPHA CRU A	1.6	SHA	173.6592	-0.0058	-0.0127	-0.0115	-0.0007	173.6477
		ACRUX	B1	DEC	-62.9772	-0.0001	-0.0049	-0.0014	0.0049	-62.9846
87		ALPHA CRU B	2.1	SHA	173.6567	-0.0058	-0.0127	-0.0115	-0.0007	173.6452
			B3	DEC	-62.9778	-0.0001	-0.0049	-0.0014	0.0049	-62.9852
88	31	GAMMA CRU	1.6	SHA	172.5158	-0.0047	-0.0126	-0.0096	-0.0004	172.5052
		GACRUX	M3	DEC	-56.9903	-0.0000	-0.0049	-0.0015	0.0045	-56.9973
89		BETA CRV	2.8	SHA	171.6929	-0.0019	-0.0117	-0.0057	-0.0001	171.6853
			G5	DEC	-23.2753	0.0000	-0.0049	-0.0022	0.0019	-23.2796

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
90		ALPHA MUS	2.9	SHA	171.0358	-0.0074	-0.0138	-0.0146	-0.0001	171.0217
			B3	DEC	-69.0144	0.0000	-0.0048	-0.0010	0.0052	-69.0220
91		GAMMA CEN	2.4	SHA	169.9263	-0.0037	-0.0125	-0.0080	0.0001	169.9162
		MUHLIFAIN	A0	DEC	-48.8392	0.0001	-0.0048	-0.0015	0.0040	-48.8455
92		GAMMA VIR	2.9	SHA	169.8642	-0.0009	-0.0114	-0.0052	0.0001	169.8575
			F0	DEC	-1.3292	0.0001	-0.0048	-0.0022	-0.0003	-1.3312
93		BETA CRU	1.5	SHA	168.3938	-0.0051	-0.0133	-0.0103	0.0004	168.3816
		MIMOSA	B1	DEC	-59.5689	0.0002	-0.0048	-0.0011	0.0047	-59.5758
94	32	EPSILON UMA	1.7	SHA	166.7338	0.0030	-0.0094	-0.0094	0.0007	166.7313
		ALIOTH	A0	DEC	56.0789	0.0002	-0.0048	-0.0014	-0.0049	56.0817
95		ALPHA-2 CVN	2.9	SHA	166.2500	0.0012	-0.0103	-0.0067	0.0005	166.2455
		COR CAROLI	A0	DEC	38.4367	0.0003	-0.0048	-0.0019	-0.0038	38.4384
96		EPSILON VIR	2.9	SHA	164.7300	-0.0003	-0.0111	-0.0053	0.0006	164.7236
			K0	DEC	11.0769	0.0003	-0.0047	-0.0023	-0.0015	11.0764
97		IOTA CEN	2.9	SHA	160.1613	-0.0026	-0.0127	-0.0065	0.0013	160.1510
			A2	DEC	-36.5967	0.0005	-0.0046	-0.0013	0.0030	-36.6014
98		ZETA UMA	2.4	SHA	159.2396	0.0027	-0.0086	-0.0090	0.0019	159.2361
		MIZAR	A2	DEC	55.0397	0.0006	-0.0046	-0.0020	-0.0048	55.0428
99	33	ALPHA VIR	1.2	SHA	158.9921	-0.0013	-0.0117	-0.0053	0.0012	158.9838
		SPICA	B2	DEC	-11.0469	0.0006	-0.0045	-0.0020	0.0007	-11.0493
100		EPSILON CEN	2.6	SHA	155.3792	-0.0041	-0.0143	-0.0085	0.0025	155.3655
			B1	DEC	-53.3550	0.0007	-0.0044	-0.0004	0.0042	-53.3606
101	34	ETA UMA	1.9	SHA	153.3313	0.0020	-0.0086	-0.0078	0.0026	153.3264
		ALKAID	B3	DEC	49.4225	0.0008	-0.0043	-0.0025	-0.0044	49.4255
102		ETA BOO	2.8	SHA	151.5908	-0.0000	-0.0105	-0.0053	0.0019	151.5836
			G0	DEC	18.5075	0.0009	-0.0043	-0.0026	-0.0021	18.5083
103		ZETA CEN	3.1	SHA	151.4604	-0.0034	-0.0140	-0.0074	0.0027	151.4473
			B2	DEC	-47.1806	0.0009	-0.0043	-0.0004	0.0037	-47.1855
104	35	BETA CEN	0.9	SHA	149.4354	-0.0049	-0.0160	-0.0100	0.0041	149.4184
		HADAR	B1	DEC	-60.2678	0.0010	-0.0042	0.0004	0.0044	-60.2733
105	36	THETA CEN	2.3	SHA	148.6546	-0.0025	-0.0133	-0.0061	0.0026	148.6428
		MENKENT	K0	DEC	-36.2625	0.0010	-0.0041	-0.0007	0.0028	-36.2663
106	37	ALPHA BOO	0.2	SHA	146.3358	-0.0000	-0.0103	-0.0051	0.0025	146.3282
		ARCTURUS	K0	DEC	19.2964	0.0011	-0.0040	-0.0028	-0.0021	19.2976
107		GAMMA BOO	3.0	SHA	142.2021	0.0009	-0.0089	-0.0060	0.0034	142.1952
			F0	DEC	38.4039	0.0013	-0.0038	-0.0032	-0.0034	38.4067
108		ETA CEN	2.6	SHA	141.4742	-0.0028	-0.0142	-0.0063	0.0037	141.4606
			*	DEC	-42.0619	0.0013	-0.0038	-0.0000	0.0030	-42.0656
109	38	ALPHA CEN A	0.3	SHA	140.4733	-0.0047	-0.0172	-0.0094	0.0058	140.4543
		RIGEL KENT.	G0	DEC	-60.7431	0.0013	-0.0037	0.0011	0.0041	-60.7477
110		ALPHA CEN B	1.7	SHA	140.4792	-0.0047	-0.0172	-0.0094	0.0058	140.4601
			K5	DEC	-60.7483	0.0013	-0.0037	0.0011	0.0041	-60.7529
111		ALPHA LUP	2.9	SHA	139.8854	-0.0031	-0.0149	-0.0068	0.0043	139.8706
			B2	DEC	-47.2947	0.0014	-0.0037	0.0004	0.0033	-47.2985
112		EPSILON BOO	2.7	SHA	138.9938	0.0003	-0.0096	-0.0051	0.0033	138.9859
			K0	DEC	27.1661	0.0014	-0.0036	-0.0032	-0.0026	27.1683

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
113	39	ALPHA-2 LIB	2.9	SHA	137.5854	-0.0014	-0.0123	-0.0047	0.0032	137.5746
		ZUBENELGENUBI	A3	DEC	-15.9514	0.0014	-0.0035	-0.0014	0.0009	-15.9526
114	40	BETA UMI	2.2	SHA	137.3113	0.0066	0.0009	-0.0165	0.0115	137.3068
		KOCHAB	K5	DEC	74.2453	0.0014	-0.0035	-0.0032	-0.0047	74.2496
115		BETA LUP	2.8	SHA	135.7292	-0.0027	-0.0147	-0.0060	0.0044	135.7147
			B2	DEC	-43.0464	0.0015	-0.0034	0.0003	0.0029	-43.0495
116		BETA LIB	2.7	SHA	131.0450	-0.0011	-0.0120	-0.0042	0.0037	131.0342
			B8	DEC	-9.3028	0.0017	-0.0031	-0.0017	0.0003	-9.3030
117		GAMMA TRA	3.1	SHA	130.7913	-0.0057	-0.0211	-0.0113	0.0100	130.7651
			A0	DEC	-68.5997	0.0017	-0.0031	0.0022	0.0039	-68.6035
118		GAMMA UMI	3.1	SHA	129.8121	0.0049	0.0006	-0.0131	0.0119	129.8054
			A2	DEC	71.9122	0.0017	-0.0030	-0.0038	-0.0042	71.9166
119		GAMMA LUP	2.9	SHA	126.5829	-0.0024	-0.0149	-0.0051	0.0052	126.5679
			B3	DEC	-41.0939	0.0018	-0.0028	0.0006	0.0024	-41.0959
120	41	ALPHA CRB	2.3	SHA	126.5613	0.0001	-0.0093	-0.0043	0.0044	126.5523
		ALPHECCA	A0	DEC	26.7878	0.0018	-0.0028	-0.0036	-0.0022	26.7904
121		ALPHA SER	2.7	SHA	124.2046	-0.0006	-0.0109	-0.0038	0.0041	124.1944
			K0	DEC	6.4939	0.0019	-0.0026	-0.0026	-0.0008	6.4953
122		BETA TRA	3.0	SHA	121.7025	-0.0040	-0.0199	-0.0080	0.0095	121.6790
			F0	DEC	-63.3644	0.0020	-0.0025	0.0024	0.0032	-63.3669
123		PI SCO	3.0	SHA	120.6208	-0.0016	-0.0135	-0.0039	0.0048	120.6077
			B2	DEC	-26.0519	0.0020	-0.0024	-0.0003	0.0012	-26.0524
124		DELTA SCO	2.5	SHA	120.2429	-0.0015	-0.0132	-0.0038	0.0047	120.2302
		DSCHUBBA	B0	DEC	-22.5603	0.0020	-0.0023	-0.0006	0.0010	-22.5605
125		BETA-1 SCO	2.9	SHA	118.9613	-0.0014	-0.0129	-0.0036	0.0047	118.9487
			B1	DEC	-19.7464	0.0020	-0.0023	-0.0007	0.0008	-19.7463
126		DELTA OPH	3.0	SHA	116.7025	-0.0009	-0.0116	-0.0032	0.0046	116.6912
			M0	DEC	-3.6389	0.0021	-0.0021	-0.0020	-0.0002	-3.6376
127		ETA DRA	2.9	SHA	114.0779	0.0017	-0.0029	-0.0064	0.0099	114.0682
			G5	DEC	61.5636	0.0022	-0.0019	-0.0048	-0.0030	61.5678
128	42	ALPHA SCO A	1.2	SHA	112.9863	-0.0015	-0.0136	-0.0033	0.0053	112.9726
		ANTARES	M0	DEC	-26.3844	0.0022	-0.0018	-0.0001	0.0010	-26.3841
129		BETA HER	2.8	SHA	112.6821	-0.0003	-0.0095	-0.0031	0.0052	112.6719
			K0	DEC	21.5364	0.0022	-0.0018	-0.0037	-0.0015	21.5392
130		TAU SCO	2.9	SHA	111.3725	-0.0015	-0.0138	-0.0032	0.0055	111.3586
			B0	DEC	-28.1717	0.0022	-0.0017	0.0001	0.0010	-28.1713
131		ZETA OPH	2.7	SHA	111.0138	-0.0010	-0.0122	-0.0028	0.0050	111.0016
			B0	DEC	-10.5239	0.0022	-0.0016	-0.0014	0.0001	-10.5226
132		ZETA HER	3.0	SHA	109.8858	-0.0001	-0.0085	-0.0032	0.0058	109.8757
			G0	DEC	31.6417	0.0022	-0.0015	-0.0043	-0.0018	31.6450
133	43	ALPHA TRA	1.9	SHA	108.4196	-0.0037	-0.0237	-0.0072	0.0140	108.3900
		ATRIA	K2	DEC	-68.9894	0.0023	-0.0014	0.0035	0.0023	-68.9902
134		EPSILON SCO	2.4	SHA	107.8163	-0.0016	-0.0146	-0.0031	0.0061	107.8013
			K0	DEC	-34.2547	0.0023	-0.0014	0.0007	0.0011	-34.2542
135		ZETA ARA	3.1	SHA	105.8017	-0.0023	-0.0184	-0.0042	0.0092	105.7810
			K5	DEC	-55.9569	0.0023	-0.0012	0.0026	0.0018	-55.9570

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
136	44	ETA OPH	2.6	SHA	102.7217	-0.0011	-0.0127	-0.0022	0.0055	102.7088
		SABIK	A2	DEC	-15.6989	0.0024	-0.0009	-0.0008	0.0002	-15.6972
137		ALPHA HER	3-4	SHA	101.5892	-0.0006	-0.0101	-0.0021	0.0055	101.5781
			M3	DEC	14.4144	0.0024	-0.0008	-0.0034	-0.0009	14.4173
138		BETA ARA	2.8	SHA	99.1338	-0.0019	-0.0185	-0.0032	0.0095	99.1131
			K2	DEC	-55.5108	0.0024	-0.0006	0.0028	0.0013	-55.5100
139		UPSILON SCO	2.8	SHA	97.6838	-0.0013	-0.0151	-0.0021	0.0068	97.6681
			B3	DEC	-37.2797	0.0024	-0.0005	0.0012	0.0007	-37.2782
140		BETA DRA	3.0	SHA	97.5167	0.0001	-0.0050	-0.0028	0.0089	97.5054
			G0	DEC	52.3169	0.0024	-0.0005	-0.0053	-0.0016	52.3207
141		ALPHA ARA	3.0	SHA	97.4658	-0.0016	-0.0172	-0.0026	0.0084	97.4472
			B3	DEC	-49.8606	0.0024	-0.0005	0.0024	0.0010	-49.8594
142	45	LAMBDA SCO	1.7	SHA	96.9721	-0.0013	-0.0151	-0.0020	0.0068	96.9564
		SHAULA	B2	DEC	-37.0892	0.0025	-0.0004	0.0012	0.0006	-37.0876
143	46	ALPHA OPH	2.1	SHA	96.5221	-0.0007	-0.0103	-0.0016	0.0056	96.5107
		RASALHAGUE	A5	DEC	12.5750	0.0025	-0.0004	-0.0033	-0.0007	12.5780
144		THETA SCO	2.0	SHA	96.0663	-0.0014	-0.0159	-0.0021	0.0075	96.0494
			F0	DEC	-42.9853	0.0025	-0.0004	0.0018	0.0007	-42.9837
145		KAPPA SCO	2.5	SHA	94.7592	-0.0013	-0.0153	-0.0019	0.0071	94.7432
			B2	DEC	-39.0203	0.0025	-0.0003	0.0014	0.0006	-39.0185
146		BETA OPH	2.9	SHA	94.4042	-0.0008	-0.0110	-0.0014	0.0055	94.3924
			K0	DEC	4.5753	0.0025	-0.0002	-0.0026	-0.0005	4.5782
147	47	GAMMA DRA	2.4	SHA	90.9767	-0.0003	-0.0051	-0.0018	0.0090	90.9648
		ELTANIN	K5	DEC	51.4908	0.0025	0.0001	-0.0054	-0.0011	51.4944
148		GAMMA SGR	3.1	SHA	88.9017	-0.0010	-0.0142	-0.0011	0.0065	88.8870
			K0	DEC	-30.4258	0.0025	0.0003	0.0007	0.0001	-30.4233
149		DELTA SGR	2.8	SHA	85.1038	-0.0009	-0.0142	-0.0007	0.0065	85.0893
			K0	DEC	-29.8389	0.0025	0.0006	0.0007	-0.0001	-29.8359
150	48	EPSILON SGR	1.9	SHA	84.3225	-0.0009	-0.0147	-0.0006	0.0069	84.3074
		KAUS AUST.	A0	DEC	-34.3967	0.0025	0.0006	0.0011	-0.0001	-34.3937
151		LAMBDA SGR	2.9	SHA	83.3471	-0.0008	-0.0137	-0.0005	0.0063	83.3331
			K0	DEC	-25.4353	0.0025	0.0007	0.0002	-0.0002	-25.4321
152	49	ALPHA LYR	0.1	SHA	80.9521	-0.0008	-0.0075	-0.0003	0.0073	80.9402
		VEGA	A0	DEC	38.7622	0.0025	0.0009	-0.0050	-0.0003	38.7656
153	50	SIGMA SGR	2.1	SHA	76.5250	-0.0007	-0.0137	0.0002	0.0063	76.5111
		NUNKI	B3	DEC	-26.3256	0.0025	0.0013	0.0003	-0.0005	-26.3218
154		ZETA SGR	2.7	SHA	74.6971	-0.0006	-0.0141	0.0004	0.0065	74.6829
			A2	DEC	-29.9131	0.0025	0.0015	0.0007	-0.0006	-29.9092
155		ZETA AQL	3.0	SHA	73.9004	-0.0009	-0.0102	0.0005	0.0058	73.8886
			A0	DEC	13.8297	0.0025	0.0015	-0.0034	-0.0002	13.8332
156		PI SGR	3.0	SHA	72.8863	-0.0006	-0.0131	0.0006	0.0060	72.8730
			F2	DEC	-21.0600	0.0025	0.0016	-0.0002	-0.0006	-21.0560
157		BETA-1 CYG	3.2	SHA	67.5417	-0.0011	-0.0090	0.0012	0.0063	67.5298
		ALBIREO	*	DEC	27.9125	0.0025	0.0020	-0.0044	0.0002	27.9157
158		DELTA CYG	3.0	SHA	63.9288	-0.0016	-0.0070	0.0019	0.0077	63.9160
			A0	DEC	45.0764	0.0024	0.0023	-0.0052	0.0009	45.0791

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
159		GAMMA AQL	2.8	SHA	63.6967	-0.0010	-0.0105	0.0014	0.0055	63.6849
			K2	DEC	10.5586	0.0024	0.0023	-0.0031	-0.0001	10.5623
160	51	ALPHA AQL	0.9	SHA	62.5729	-0.0009	-0.0107	0.0015	0.0055	62.5612
		ALTAIR	A5	DEC	8.8092	0.0024	0.0024	-0.0030	-0.0001	8.8129
161		GAMMA CYG	2.3	SHA	54.6408	-0.0018	-0.0080	0.0028	0.0067	54.6283
			F8	DEC	40.1856	0.0023	0.0030	-0.0048	0.0013	40.1880
162	52	ALPHA PAV	2.1	SHA	54.0217	0.0010	-0.0173	0.0040	0.0093	54.0048
		PEACOCK	B3	DEC	-56.8069	0.0022	0.0030	0.0028	-0.0023	-56.8008
163		ALPHA IND	3.2	SHA	50.9942	0.0006	-0.0154	0.0036	0.0073	50.9798
			K0	DEC	-47.3694	0.0022	0.0032	0.0019	-0.0023	-47.3633
164	53	ALPHA CYG	1.3	SHA	49.8300	-0.0022	-0.0077	0.0036	0.0069	49.8171
		DENEB	A2	DEC	45.2011	0.0021	0.0033	-0.0048	0.0018	45.2031
165		EPSILON CYG	2.6	SHA	48.6700	-0.0017	-0.0089	0.0032	0.0058	48.6580
			K0	DEC	33.8872	0.0021	0.0034	-0.0044	0.0013	33.8897
166		ALPHA CEP	2.6	SHA	40.4867	-0.0040	-0.0054	0.0070	0.0094	40.4705
		ALDERAMIN	A5	DEC	62.4919	0.0019	0.0039	-0.0047	0.0031	62.4927
167		BETA AQR	3.1	SHA	37.4000	-0.0006	-0.0116	0.0035	0.0042	37.3894
			G0	DEC	-5.6686	0.0018	0.0040	-0.0018	-0.0008	-5.6640
168	54	EPSILON PEG	2.5	SHA	34.2242	-0.0011	-0.0109	0.0037	0.0040	34.2136
		ENIF	K0	DEC	9.7736	0.0017	0.0042	-0.0028	0.0003	9.7771
169		DELTA CAP	3.0	SHA	33.5433	-0.0003	-0.0121	0.0039	0.0040	33.5330
			A5	DEC	-16.2278	0.0017	0.0042	-0.0011	-0.0015	-16.2224
170	55	ALPHA GRU	2.2	SHA	28.2871	0.0014	-0.0137	0.0059	0.0051	28.2765
		AL NA'IR	B5	DEC	-47.0683	0.0015	0.0044	0.0009	-0.0036	-47.0611
171		ALPHA TUC	2.9	SHA	25.7488	0.0029	-0.0149	0.0085	0.0066	25.7376
			K2	DEC	-60.3700	0.0014	0.0045	0.0016	-0.0042	-60.3621
172		BETA GRU	2.2	SHA	19.6604	0.0016	-0.0130	0.0066	0.0041	19.6515
			M3	DEC	-47.0003	0.0012	0.0047	0.0004	-0.0039	-46.9928
173	56	ALPHA PSA	1.3	SHA	15.8908	0.0005	-0.0120	0.0054	0.0028	15.8825
		FOMALHAUT	A3	DEC	-29.7392	0.0010	0.0048	-0.0008	-0.0029	-29.7329
174		BETA PEG	2.6	SHA	14.3238	-0.0021	-0.0108	0.0054	0.0026	14.3137
		SCHEAT	M0	DEC	27.9631	0.0010	0.0048	-0.0030	0.0021	27.9643
175	57	ALPHA PEG	2.6	SHA	14.0842	-0.0014	-0.0111	0.0049	0.0023	14.0748
		MARKAB	A0	DEC	15.0867	0.0010	0.0048	-0.0027	0.0010	15.0891
176		GAMMA CEP	3.4	SHA	5.3921	-0.0120	-0.0100	0.0232	0.0067	5.3684
			K0	DEC	77.5097	0.0006	0.0049	-0.0019	0.0053	77.5075

ALMANAC
FOR
COMPUTERS

For the Year

1979

Nautical Almanac Office
United States Naval Observatory
Washington, D. C. 20390

A. Fenoind

ALMANAC FOR COMPUTERS, 1979 — CORRECTIONS

Page A10, lines 18, 19: the suggested value of ΔT for 1979 is $50^{s}.3 = 0^{d}.000582$.

Page A10, Example 2, line 2: data in this example is for 6 May 1979 not 6 May 1978.

Page A12, line 12: $f(x) = (b_0 - b_2)/2 = (5.815733 - 0.0728500)/2$

Page A14, example for computing the declination of Betelgeuse:

$$+S_D \sin 360°\tau \quad = \quad -0.0014$$
$$\text{Apparent decl.} \quad = \quad +7^{\circ}.4003$$

Page B3, lines 7 and 15 from the bottom of the page: references to pages D1—D4 and E1 should be to pages D3—D6 and D31.

Page B6, line1: the formulas are for 1979 not 1978.

Page B7, the example for computing the time of sunset at Washington, D.C., beginning with line 8:

$L = 179^{\circ}.779 + 1^{\circ}.916(+0.00385) + 0^{\circ}.020(-0.00771) + 282^{\circ}.588$
$= 462^{\circ}.374 = 102^{\circ}.374$

$\tan a = 0.91746(-4.5581) = -4.1819$

$a = 103^{\circ}.448 = 6^{h}.897$ Since L is in quadrant 2, so is a.

$\sin\delta = 0.39782(0.97677) = 0.38858$

$\cos\delta = 0.92142$

$\cos H = [-0.01454 - (0.38858)(0.62796)]/[(0.92142)(0.77824)]$
$= -0.36056$

Since sunset is being computed and $\cos H$ is negative, H is in the second quadrant:

$H = 111^{\circ}.135 = 7^{h}.409$

$T = 7^{h}.409 + 6^{h}.897 - 0^{h}.065710(185.9641) - 6^{h}.604 = -4^{h}.518$
$= 19^{h}.482$

$UT = 19^{h}.482 + 5^{h}.138 = 24^{h}.620$

Sunset occurred at $0^{h}37^{m}$ UT on 5 July = $20^{h}37^{m}$ EDT on 4 July.

Page B11, line 5: the reference to Section F should be to Section E.

Page C10: the series for days 55 — 60 (Feb 24 — Mar 1) should be replaced by the following:

DAYS 55 THRU 60 JD 2443928.5 TO 2443934.5 DATES FEB 24 THRU MAR 1
A = 3.00000000 B = −19.33333333

	MOON GHA	MOON DEC	MOON HP	MOON SD
TERM	DEG	DEG	DEG	DEG
0	1252.9840	−6.5824	1.0180	0.2774
1	1039.3249	13.3525	−0.0197	−0.0054
2	1.9263	1.6657	−0.0233	−0.0064
3	−0.0267	−1.6005	0.0135	0.0037
4	−0.2507	−0.0168	0.0020	0.0005
5	0.0649	0.0976	−0.0093	−0.0025
SUMS	2294.0227	6.9161	0.9812	0.2673

Page C17: the series for days 229 — 234 (Aug 17 — Aug 22) should be replaced by the following:

DAYS 229 THRU 234 JD 2444102.5 TO 2444108.5 DATES AUG 17 THRU AUG 22
A = 3.00000000 B = −77.33333333

	MOON GHA	MOON DEC	MOON HP	MOON SD
TERM	DEG	DEG	DEG	DEG
0	1289.6416	17.3475	0.9074	0.2472
1	1045.4753	−4.3141	−0.0178	−0.0049
2	1.3969	−3.4252	0.0059	0.0016
3	0.1791	0.4336	0.0095	0.0026
4	−0.1130	0.0831	0.0014	0.0004
5	−0.0255	−0.0154	−0.0071	−0.0019
SUMS	2336.5544	10.1095	0.8993	0.2450

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Table of Contents

Section A: EXPLANATION

Introduction

The *Almanac for Computers* has been designed to facillitate the application of digital computers and small calculators to problems of astronomy and navigation which require coordinates of celestial bodies. For such applications the fixed-interval tabulations of the *American Ephemeris and Nautical Almanac (AE),* the *Nautical Almanac (NA)* and the *Air Almanac (AA)*, with the inevitable requirements of interpolation, should ideally be replaced by concise mathematical expression for direct calculations. Such expressions must take the form of mathematical approximations, however, since the precise data contained in the above publications are calculated from extensive theories which are not readily adaptable to the majority of astronomical and navigational applications. Using the expressions in this almanac, it is possible to calculate, with minimal loss of precision, the basic data in the *AE, NA* and *AA* for specific times and conditions. More specific information on precision is given in Tables 1, 2 and 3 of this section.

In this third edition we retain the basic methods of the previous edition. However, the format of the publication continues to evolve as suggestions from users are evaluated and implemented. In the 1978 edition there appeared trigonometric series which provided low precision approximations of planetary positions for several centuries. These series are not included in the present edition. Instead an expanded version of this work will soon be published in the standard astronomical literature. Further information may be obtained from the Director, Nautical Almanac Office.

For most efficient use with computers, the data in Sections D and E are available on punched cards or magnetic tape.

Continued improvements in the *Almanac for Computers* will depend on further input from users. Inquiries, suggestions and comments should be sent to the Director, Nautical Almanac Office, U. S. Naval Observatory, Washington, D.C. 20390.

Day of Month	JANUARY			FEBRUARY			MARCH			APRIL		
	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year
	2443			2443			2443			2443		
1	874.5	Mon.	1	905.5	Thu.	32	933.5	Thu.	60	964.5	Sun.	91
2	875.5	Tue.	2	906.5	Fri.	33	934.5	Fri.	61	965.5	Mon.	92
3	876.5	Wed.	3	907.5	Sat.	34	935.5	Sat.	62	966.5	Tue.	93
4	877.5	Thu.	4	908.5	Sun.	35	936.5	Sun.	63	967.5	Wed.	94
5	878.5	Fri.	5	909.5	Mon.	36	937.5	Mon.	64	968.5	Thu.	95
6	879.5	Sat.	6	910.5	Tue.	37	938.5	Tue.	65	969.5	Fri.	96
7	880.5	Sun.	7	911.5	Wed.	38	939.5	Wed.	66	970.5	Sat.	97
8	881.5	Mon.	8	912.5	Thu.	39	940.5	Thu.	67	971.5	Sun.	98
9	882.5	Tue.	9	913.5	Fri.	40	941.5	Fri.	68	972.5	Mon.	99
10	883.5	Wed.	10	914.5	Sat.	41	942.5	Sat.	69	973.5	Tue.	100
11	884.5	Thu.	11	915.5	Sun.	42	943.5	Sun.	70	974.5	Wed.	101
12	885.5	Fri.	12	916.5	Mon.	43	944.5	Mon.	71	975.5	Thu.	102
13	886.5	Sat.	13	917.5	Tue.	44	945.5	Tue.	72	976.5	Fri.	103
14	887.5	Sun.	14	918.5	Wed.	45	946.5	Wed.	73	977.5	Sat.	104
15	888.5	Mon.	15	919.5	Thu.	46	947.5	Thu.	74	978.5	Sun.	105
16	889.5	Tue.	16	920.5	Fri.	47	948.5	Fri.	75	979.5	Mon.	106
17	890.5	Wed.	17	921.5	Sat.	48	949.5	Sat.	76	980.5	Tue.	107
18	891.5	Thu.	18	922.5	Sun.	49	950.5	Sun.	77	981.5	Wed.	108
19	892.5	Fri.	19	923.5	Mon.	50	951.5	Mon.	78	982.5	Thu.	109
20	893.5	Sat.	20	924.5	Tue.	51	952.5	Tue.	79	983.5	Fri.	110
21	894.5	Sun.	21	925.5	Wed.	52	953.5	Wed.	80	984.5	Sat.	111
22	895.5	Mon.	22	926.5	Thu.	53	954.5	Thu.	81	985.5	Sun.	112
23	896.5	Tue.	23	927.5	Fri.	54	955.5	Fri.	82	986.5	Mon.	113
24	897.5	Wed.	24	928.5	Sat.	55	956.5	Sat.	83	987.5	Tue.	114
25	898.5	Thu.	25	929.5	Sun.	56	957.5	Sun.	84	988.5	Wed.	115
26	899.5	Fri.	26	930.5	Mon.	57	958.5	Mon.	85	989.5	Thu.	116
27	900.5	Sat.	27	931.5	Tue.	58	959.5	Tue.	86	990.5	Fri.	117
28	901.5	Sun.	28	932.5	Wed.	59	960.5	Wed.	87	991.5	Sat.	118
29	902.5	Mon.	29				961.5	Thu.	88	992.5	Sun.	119
30	903.5	Tue.	30				962.5	Fri.	89	993.5	Mon.	120
31	904.5	Wed.	31				963.5	Sat.	90			

The Julian Day begins at noon.

Day of Month	MAY			JUNE			JULY			AUGUST		
	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year
	2443			2444			2444			2444		
1	994.5	Tue.	121	025.5	Fri.	152	055.5	Sun.	182	086.5	Wed.	213
2	995.5	Wed.	122	026.5	Sat.	153	056.5	Mon.	183	087.5	Thu.	214
3	996.5	Thu.	123	027.5	Sun.	154	057.5	Tue.	184	088.5	Fri.	215
4	997.5	Fri.	124	028.5	Mon.	155	058.5	Wed.	185	089.5	Sat.	216
5	998.5	Sat.	125	029.5	Tue.	156	059.5	Thu.	186	090.5	Sun.	217
6	999.5	Sun.	126	030.5	Wed.	157	060.5	Fri.	187	091.5	Mon.	218
7	*000.5	Mon.	127	031.5	Thu.	158	061.5	Sat.	188	092.5	Tue.	219
8	*001.5	Tue.	128	032.5	Fri.	159	062.5	Sun.	189	093.5	Wed.	220
9	*002.5	Wed.	129	033.5	Sat.	160	063.5	Mon.	190	094.5	Thu.	221
10	*003.5	Thu.	130	034.5	Sun.	161	064.5	Tue.	191	095.5	Fri.	222
11	*004.5	Fri.	131	035.5	Mon.	162	065.5	Wed.	192	096.5	Sat.	223
12	*005.5	Sat.	132	036.5	Tue.	163	066.5	Thu.	193	097.5	Sun.	224
13	*006.5	Sun.	133	037.5	Wed.	164	067.5	Fri.	194	098.5	Mon.	225
14	*007.5	Mon.	134	038.5	Thu.	165	068.5	Sat.	195	099.5	Tue.	226
15	*008.5	Tue.	135	039.5	Fri.	166	069.5	Sun.	196	100.5	Wed.	227
16	*009.5	Wed.	136	040.5	Sat.	167	070.5	Mon.	197	101.5	Thu.	228
17	*010.5	Thu.	137	041.5	Sun.	168	071.5	Tue.	198	102.5	Fri.	229
18	*011.5	Fri.	138	042.5	Mon.	169	072.5	Wed.	199	103.5	Sat.	230
19	*012.5	Sat.	139	043.5	Tue.	170	073.5	Thu.	200	104.5	Sun.	231
20	*013.5	Sun.	140	044.5	Wed.	171	074.5	Fri.	201	105.5	Mon.	232
21	*014.5	Mon.	141	045.5	Thu.	172	075.5	Sat.	202	106.5	Tue.	233
22	*015.5	Tue.	142	046.5	Fri.	173	076.5	Sun.	203	107.5	Wed.	234
23	*016.5	Wed.	143	047.5	Sat.	174	077.5	Mon.	204	108.5	Thu.	235
24	*017.5	Thu.	144	048.5	Sun.	175	078.5	Tue.	205	109.5	Fri.	236
25	*018.5	Fri.	145	049.5	Mon.	176	079.5	Wed.	206	110.5	Sat.	237
26	*019.5	Sat.	146	050.5	Tue.	177	080.5	Thu.	207	111.5	Sun.	238
27	*020.5	Sun.	147	051.5	Wed.	178	081.5	Fri.	208	112.5	Mon.	239
28	*021.5	Mon.	148	052.5	Thu.	179	082.5	Sat.	209	113.5	Tue.	240
29	*022.5	Tue.	149	053.5	Fri.	180	083.5	Sun.	210	114.5	Wed.	241
30	*023.5	Wed.	150	054.5	Sat.	181	084.5	Mon.	211	115.5	Thu.	242
31	*024.5	Thu.	151				085.5	Tue.	212	116.5	Fri.	243

The Julian Day begins at noon.

CALENDAR, 1979

Day of Month	SEPTEMBER Julian Date at 0^h	SEPTEMBER Day of Week	SEPTEMBER Day of Year	OCTOBER Julian Date at 0^h	OCTOBER Day of Week	OCTOBER Day of Year	NOVEMBER Julian Date at 0^h	NOVEMBER Day of Week	NOVEMBER Day of Year	DECEMBER Julian Date at 0^h	DECEMBER Day of Week	DECEMBER Day of Year
	2444			2444			2444			2444		
1	117.5	Sat.	244	147.5	Mon.	274	178.5	Thu.	305	208.5	Sat.	335
2	118.5	Sun.	245	148.5	Tue.	275	179.5	Fri.	306	209.5	Sun.	336
3	119.5	Mon.	246	149.5	Wed.	276	180.5	Sat.	307	210.5	Mon.	337
4	120.5	Tue.	247	150.5	Thu.	277	181.5	Sun.	308	211.5	Tue.	338
5	121.5	Wed.	248	151.5	Fri.	278	182.5	Mon.	309	212.5	Wed.	339
6	122.5	Thu.	249	152.5	Sat.	279	183.5	Tue.	310	213.5	Thu.	340
7	123.5	Fri.	250	153.5	Sun.	280	184.5	Wed.	311	214.5	Fri.	341
8	124.5	Sat.	251	154.5	Mon.	281	185.5	Thu.	312	215.5	Sat.	342
9	125.5	Sun.	252	155.5	Tue.	282	186.5	Fri.	313	216.5	Sun.	343
10	126.5	Mon.	253	156.5	Wed.	283	187.5	Sat.	314	217.5	Mon.	344
11	127.5	Tue.	254	157.5	Thu.	284	188.5	Sun.	315	218.5	Tue.	345
12	128.5	Wed.	255	158.5	Fri.	285	189.5	Mon.	316	219.5	Wed.	346
13	129.5	Thu.	256	159.5	Sat.	286	190.5	Tue.	317	220.5	Thu.	347
14	130.5	Fri.	257	160.5	Sun.	287	191.5	Wed.	318	221.5	Fri.	348
15	131.5	Sat.	258	161.5	Mon.	288	192.5	Thu.	319	222.5	Sat.	349
16	132.5	Sun.	259	162.5	Tue.	289	193.5	Fri.	320	223.5	Sun.	350
17	133.5	Mon.	260	163.5	Wed.	290	194.5	Sat.	321	224.5	Mon.	351
18	134.5	Tue.	261	164.5	Thu.	291	195.5	Sun.	322	225.5	Tue.	352
19	135.5	Wed.	262	165.5	Fri.	292	196.5	Mon.	323	226.5	Wed.	353
20	136.5	Thu.	263	166.5	Sat.	293	197.5	Tue.	324	227.5	Thu.	354
21	137.5	Fri.	264	167.5	Sun.	294	198.5	Wed.	325	228.5	Fri.	355
22	138.5	Sat.	265	168.5	Mon.	295	199.5	Thu.	326	229.5	Sat.	356
23	139.5	Sun.	266	169.5	Tue.	296	200.5	Fri.	327	230.5	Sun.	357
24	140.5	Mon.	267	170.5	Wed.	297	201.5	Sat.	328	231.5	Mon.	358
25	141.5	Tue.	268	171.5	Thu.	298	202.5	Sun.	329	232.5	Tue.	359
26	142.5	Wed.	269	172.5	Fri.	299	203.5	Mon.	330	233.5	Wed.	360
27	143.5	Thu.	270	173.5	Sat.	300	204.5	Tue.	331	234.5	Thu.	361
28	144.5	Fri.	271	174.5	Sun.	301	205.5	Wed.	332	235.5	Fri.	362
29	145.5	Sat.	272	175.5	Mon.	302	206.5	Thu.	333	236.5	Sat.	363
30	146.5	Sun.	273	176.5	Tue.	303	207.5	Fri.	334	237.5	Sun.	364
31				177.5	Wed.	304				238.5	Mon.	365

The Julian Day begins at noon.

Navigational Tables

Section C contains mathematical representations of the following functions that are tabulated in the *Nautical Almanac (NA)*: the GHA of Aries, the GHA and declination of the Sun, Moon and navigational planets, the semi-diameter of the Sun and Moon, and the horizontal parallax of the Moon. These functions are expressed for a specified time span by a power series of the form

$$f(x) = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + a_4 x^4 + a_5 x^5$$

In the series x is a time-like variable which takes on values between -1 and $+1$ over the specified time span; $a_0, a_1, a_2, a_3, a_4, a_5$ are coefficients which are tabulated in Section C for the specified time span; and $f(x)$ represents the value of the function (*e.g.*, the GHA of Aries) evaluated at time x.

To evaluate the series for one of the navigational functions, one must first find the set of coefficients in Section C that is applicable for the desired date. Constants A and B are given there for the purpose of converting the calendar date and GMT to the time-like variable x. To obtain the value of x for the desired time, first determine t, the GMT measured in days and fractions thereof from 0 January, 0^h GMT, from the relation $t = N + \text{GMT}/24$, where N is the day of the year at Greenwich and GMT is the Greenwich Mean Time expressed in hours. A calendar is provided on pages A2–A4 for finding the day of the year; alternatively the day of the year can be computed from the formulas given on pages B1 and B2. Once t has been determined, x is computed from the relation $x = t/A + B$. If computed correctly, the value of x should fall in the range of $-1 \leqslant x \leqslant +1$.

Example 1: Compute x for later use in computing the position of the Sun at $10^h 35^m 00^s$ GMT ($=0^d\!.4409722$) on 14 May 1979.
From the calendar on page A3, 14 May is found to be day 134. Thus $t = 134 + 0.4409722$. This date is in the interval 1 May through 1 June (days 121 through 152) for which coefficients for the Sun are given on page C4. The constants for this interval are $A = 16.0$ and $B = -8.5625$. Therefore $x = 134.4409722/16.0 - 8.5625 = -0.1599392$.

Once the variable x has been computed and the coefficients a_i have been found, the series $f(x) = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + a_4 x^4 + a_5 x^5$ can be evaluated. The series can be evaluated most efficiently by computing a set of five auxiliary variables, b_1, b_2, b_3, b_4, b_5, in the following order:

$$
\begin{aligned}
b_5 &= x a_5 \\
b_4 &= x(a_4 + b_5) \\
b_3 &= x(a_3 + b_4) \\
b_2 &= x(a_2 + b_3) \\
b_1 &= x(a_1 + b_2) \\
f(x) &= a_0 + b_1
\end{aligned}
$$

By using this algorithm, the series is evaluated in its nested form $f(x) = a_0 + x(a_1 + x(a_2 + x(a_3 + x(a_4 + xa_5))))$.

Example 2: Compute the GHA of the Sun at $10^h 35^m 00^s$ GMT on 14 May 1979.

From the previous example $x = -0.1599392$. The coefficients for the Sun's GHA are found on page C4.

b_5	$= -0.1599392\ (-0.0004)$	$= +0.0001$
b_4	$= -0.1599392\ (0.0123 + 0.0001)$	$= -0.0020$
b_3	$= -0.1599392\ (0.0101 - 0.0020)$	$= -0.0013$
b_2	$= -0.1599392\ (-0.3067 - 0.0013)$	$= +0.0493$
b_1	$= -0.1599392\ (5759.9199 + 0.0493)$	$= -921.2449$
$f(-0.1599392)$	$= 5940.9244 - 921.2449$	$= 5019\overset{\circ}{.}6795$

Therefore GHA $= 339\overset{\circ}{.}6795 = 339°40\overset{\prime}{.}8$

Note that when computing the GHA, it may be necessary to reduce the final result to the range 0°–360° by subtracting multiples of 360°.

Example 3: Compute the declination of the Moon at $21^h 40^m 25^s$ GMT on 2 October 1979.

The constants A and B and series coefficients are found on page C19.

x	$= 275.9030671 / 3.0 - 91.3333333$	$= +0.6343557$
b_5	$= 0.6343557\ (-0.0027)$	$= -0.0017$
b_4	$= 0.6343557\ (-0.3237 - 0.0017)$	$= -0.2064$
b_3	$= 0.6343557\ (-0.3415 - 0.2064)$	$= -0.3476$
b_2	$= 0.6343557\ (4.9584 - 0.3476)$	$= +2.9249$
b_1	$= 0.6343557\ (6.0133 + 2.9249)$	$= +5.6700$
$f(0.6343557)$	$= -16.8809 + 5.6700$	$= -11\overset{\circ}{.}2109$

declination $= -11°\ 12\overset{\prime}{.}7$

Although the series are designed to provide precision comparable to that published in the *NA*, there will be small discrepencies between the tabulated values and the values computed from the series. In such cases it should be understood that the *NA* represents the standard. Table 1 lists the largest discrepencies found from evaluating and comparing the series with the data in the *NA*.

Under no circumstances should the series be used to extrapolate data beyond the specified time interval. Such extrapolation will lead to erroneous and useless results.

In accordance with standard practice for navigational almanacs, the time argument used in this almanac is Greenwich Mean Time (GMT), or more specifically UT1. To obtain full precision in the determined positions, the radio time signals in UTC must be corrected to UT1, or GMT, according to standard procedures. (See the paper by R. L. Duncombe and P. K. Seidelmann, 'The New UTC Time Signals', *Navigation*, 24, 160–165, 1977.)

Beneath each set of coefficients in Section C is printed the sum of the coefficients. As a check on whether the coefficients have been entered accurately into the calculator, it is recommended that the coefficients be summed and that the resulting sum be compared with the printed sum.

Table 1: Comparison of *Almanac for Computers* with *NA*

Function		No. of Terms	Span of Validity	Maximum Error
GHA of Aries		6	32 days	0.′2
Sun:	GHA	"	"	0.′2
	Declination	"	"	0.′2
	Semi-Diameter	"	"	0.′1
Moon:	GHA	"	6 days	0.′2
	Declination	"	"	0.′2
	Horizontal Parallax	"	"	0.′2
	Semi-Diameter	"	"	0.′1
Navigational Planets:	GHA	"	32 days	0.′2
	Declination	"	"	0.′2

Astronomical Tables

Section D contains mathematical representations of data published in the *American Ephemeris and Nautical Almanac (AE).* Chebyshev expansions have been chosen as the means of representation since they provide efficient and accurate expressions that can be easily evaluated with a small computer. The coefficients a_i of the Chebyshev expansion

$$f(x) = a_0/2 + \sum_{i=1}^{n} a_i T_i(x)$$

are tabulated for prescribed time spans, where $f(x)$ is the function being represented, $T_i(x)$ is the Chebyshev polynomial of the first kind of the *i-th* degree, and x is the normalized time variable. Although Chebyshev polynomials appear in the formal series expansions, the series can be evaluated without explicitly computing these polynomials. No *a priori* knowledge of Chebyshev analysis is required to use the series in this almanac. Interested readers can find information on Chebyshev analysis in *Applied Analysis* by C. Lanczos and *Chebyshev Polynomials in Numerical Analysis* by L. Fox and I. B. Parker.

It must be emphasized that the series are valid only over the specified time intervals. Attempts to extrapolate data using these series will yield erroneous and useless results.

If precision comparable to that of the *AE* is required, the series on pages D3 – D30 should be used. With the exception of the series for the Moon, these series are valid for time spans of approximately three months; for the Moon the span of validity is approximately one month. Table 2 lists the largest errors found by evaluating the series and comparing the results with the data printed in the *AE*.

It is possible to develop series which are valid for longer time spans, if one is willing to relax the precision of the approximations. Pages D31 – D34 contain series which are valid for one full year, but which are not as precise as the series on pages D3 – D30. The precision criteria of these less precise series are summarized in Table 3.

Chebyshev series can be truncated according to the following precept to obtain shorter series meeting imposed precision limits. Beginning with the last coefficient, add the absolute values of the coefficients until the required limit of precision is accumulated. The series may be safely truncated at this point, and the small terms omitted.

Example 1: For use in the next example, determine the number of terms required to compute the apparent right ascension of the Sun to a precision of $\pm 0\overset{s}{.}5$ (= $\pm 0\overset{h}{.}00014$) on 6 May 1979.

From Table 3 it is seen that the lower precision series on page D31 cannot be relied upon to give the required precision. As shown in Table 2 the higher precision series on page D7 provide higher precision than is necessary, and

Table 2: Comparison of *Almanac for Computers* and *AE*
(High Precision Series, pp. D3 – D30)

Function		No. of Terms	Span of Validity	Maximum Error
Apparent Sidereal Time at 0^h UT		36	95 days	$0\overset{s}{.}001$
Equation of the Equinoxes		"	"	$0\overset{s}{.}001$
Nutation in Longitude		"	"	$0\overset{''}{.}007$
Nutation in Obliquity		"	"	$0\overset{''}{.}003$
Sun:	Right Ascension	22	95 days	$0\overset{s}{.}02$
	Declination	"	"	$0\overset{''}{.}1$
	Distance	"	"	4×10^{-7} AU
	Semi-Diameter	"	"	$0\overset{''}{.}02$
	Ephemeris Transit	"	"	$0\overset{s}{.}01$
Moon:	Right Ascension	36	32 days	$0\overset{s}{.}002$
	Declination	"	"	$0\overset{''}{.}02$
	Horizontal Parallax	"	"	$0\overset{''}{.}01$
	Geocentric Rectangular Coods.	"	"	1×10^{-6} Earth radii
Mercury:	Right Ascension	40	95 days	$0\overset{s}{.}04$
	Declination	"	"	$0\overset{''}{.}3$
	Distance	"	"	1×10^{-6} AU
Venus:	Right Ascension	40	95 days	$0\overset{s}{.}01$
	Declination	"	"	$0\overset{''}{.}1$
	Distance	"	"	1×10^{-6} AU
Mars:	Right Ascension	22	95 days	$0\overset{s}{.}02$
	Declination	"	"	$0\overset{''}{.}2$
	Distance	"	"	1×10^{-6} AU
Jupiter:	Right Ascension	22	95 days	$0\overset{s}{.}02$
	Declination	"	"	$0\overset{''}{.}2$
	Distance	"	"	1×10^{-6} AU
Saturn:	Right Ascension	22	95 days	$0\overset{s}{.}02$
	Declination	"	"	$0\overset{''}{.}2$
	Distance	"	"	1×10^{-6} AU
Uranus:	Right Ascension	22	95 days	$0\overset{s}{.}02$
	Declination	"	"	$0\overset{''}{.}2$
	Distance	"	"	7×10^{-6} AU
Neptune:	Right Ascension	22	95 days	$0\overset{s}{.}02$
	Declination	"	"	$0\overset{''}{.}2$
	Distance	"	"	9×10^{-6} AU
Pluto:	Right Ascension (astrometric)	22	95 days	$0\overset{s}{.}001$
	Declination (astrometric)	"	"	$0\overset{''}{.}01$
	Distance	"	"	1×10^{-6} AU

therefore can be truncated. Summing the absolute values of coefficients 22 through 9 for the Sun's right ascension gives a total of $0^h.0000898$; adding to this the absolute value of coefficient 8 increases the total to $0^h.0001695$, which exceeds the limit of precision. Therfore terms 9 through 22 can be safely dropped, and terms 0 through 8 of this series provide precision of $\pm 0^s.5$.

To evaluate the approximations, one must first normalize the time variable to the interval for which the series is valid. The normalized time x is determined from a relation of the form $x = t/A + B$, where values of A and B are given for each set of coefficients and t is reckoned in days and fractions thereof from 0 January. If correctly computed, the value of x will fall in the range $-1 \leqslant x \leqslant +1$.

For the functions Apparent Sidereal Time at 0^h UT, the Equation of the Equinoxes, Nutation in Longitude and Nutation in Latitude, the variable t is measured in days of Universal Time from 0 January, 0^h UT. For all other functions in Section D, t is measured in days of ephemeris time from 0 January, 0^h ET. These latter functions can be evaluated for Universal Times, however, by using the normalizing relation $x = (t' + \Delta T)/A + B$, where t' is the Universal Time measured in days from 0 January, 0^h UT. As this volume goes to press, $\Delta T = 49^s.3$ ($=0^d.000571$) appears to be a reliable value to use in 1978. Care should be taken to verify that the sum $t' + \Delta T$ falls within the time span for which the series is valid; if it falls outside, the series and constants for the next span should be used.

Once the normalized time variable x is determined, the approximation

$$f(x) = a_0/2 + \sum_{i=1}^{n} a_i T_i(x)$$

where the a_i are the printed coefficients, can be evaluated as follows:

let $\quad b_{n+1} = b_{n+2} = 0,$

compute $\quad b_i = 2xb_{i+1} - b_{i+2} + a_i, \quad$ for $i = n, n-1, \ldots, 0,$

then $\quad f(x) = (b_0 - b_2)/2.$

Example 2: Compute the apparent right ascension of the Sun to a precision of $\pm 0^s.5$ at $16^h 08^m 04^s$ UT ($=0^d.672269$) on 6 May 1978.

From the previous example we know that terms 0 through 8 of the series on page D7 must be carried to ensure the required precision on this date. Using the calendar (page A3) or the formulas on page B2, it is found that 6 May is day 126. Since the series for solar coordinates are based on ephemeris time, it is necessary to add ΔT to the specified Universal Time. Therefore

$t = 126 + 0.672269 + 0.000581 = 126.672850$

On page D7 are found the constants for the time span $A = 47.5$ and $B = 2.91578947$. Therefore

$x = 126.672850 / 47.5 - 2.91578947 = -0.248992628$

With this value of x and the coefficients from page D7, the algorithm works as follows:

Table 3: Comparison of *Almanac for Computers* and *AE*
(Low Precision Series, pp. D31 – D34)

Function		No. of Terms	Maximum Error
Apparent Sidereal Time at 0^h UT		10	$0^s.03$
Equation of the Equinoxes		"	$0^s.03$
Nutation in Longitude		"	$0''.3$
Nutation in Obliquity		"	$0''.2$
Sun:	Right Ascension	22	$0^s.6$
	Declination	"	$3''$
	Distance	"	4×10^{-5} AU
	Semi-Diameter	"	$0''.05$
	Ephemeris Transit	"	$0^s.6$
Mercury:	Right Ascension	50	9^s
	Declination	"	$1'.1$
	Distance	"	5×10^{-4} AU
Venus:	Right Ascension	50	$0^s.03$
	Declination	"	$0''.2$
	Distance	"	2×10^{-6} AU
Mars:	Right Ascension	22	$0^s.4$
	Declination	"	$2''$
	Distance	"	4×10^{-5} AU
Jupiter:	Right Ascension	22	$0^s.2$
	Declination	"	$0''.4$
	Distance	"	4×10^{-5} AU
Saturn:	Right Ascension	22	$0^s.1$
	Declination	"	$0''.4$
	Distance	"	4×10^{-5} AU
Uranus:	Right Ascension	22	$0^s.1$
	Declination	"	$0''.3$
	Distance	"	4×10^{-5} AU
Neptune:	Right Ascension	22	$0^s.05$
	Declination	"	$0''.3$
	Distance	"	5×10^{-5} AU
Pluto:	Right Ascension (Astrometric)	22	$0^s.02$
	Declination (Astrometric)	"	$0''.2$
	Distance	"	4×10^{-5} AU

$$
\begin{array}{llllllll}
b_{n+2} & = b_{10} & = 0 & & & & & \\
b_{n+1} & = b_{9} & = 0 & & & & & \\
b_{n} & = b_{8} & = 2xb_{9} & - b_{10} & + & a_{8} & = & -0.0000797 \\
 & b_{7} & = 2xb_{8} & - b_{9} & + & a_{7} & = & +0.0000575 \\
 & b_{6} & = 2xb_{7} & - b_{8} & + & a_{6} & = & +0.0001991 \\
 & b_{5} & = 2xb_{6} & - b_{7} & + & a_{5} & = & -0.0000755 \\
 & b_{4} & = 2xb_{5} & - b_{6} & + & a_{4} & = & -0.0050687 \\
 & b_{3} & = 2xb_{4} & - b_{5} & + & a_{3} & = & -0.0038659 \\
 & b_{2} & = 2xb_{3} & - b_{4} & + & a_{2} & = & +0.0728500 \\
 & b_{1} & = 2xb_{2} & - b_{3} & + & a_{1} & = & +3.0962149 \\
 & b_{0} & = 2xb_{1} & - b_{2} & + & a_{0} & = & +5.8157333
\end{array}
$$

$$f(x) = (b_0 - b_2)/2 = (16.9239355 + 0.0756807)/2$$

$$\mathrm{RA} = 2^{\mathrm{h}}.8714416 = 2^{\mathrm{h}}\,52^{\mathrm{m}}\,17^{\mathrm{s}}.2$$

Beneath each set of coefficients is printed the sum of the coefficients. This may be used as an easy means of verifying the accuracy with which the coefficients have been entered in the computer.

With two exceptions the series in Section D provide data referred to the true equator and equinox of date. The exceptions are

1. the Moon's geocentric, rectangular coordinates (X, Y, Z), which are referred to the mean equator and equinox of 1950.0;
2. the right ascension and declination of Pluto, which are astrometric (*i.e.*, free of the effect of stellar aberration, except for the elliptic part) and are referred to the mean equator and equinox of 1950.0.

The unit of distance for the Sun and planets is the Astronomical Unit; the unit of distance for the Moon is the Earth's equatorial radius.

Stellar Tables

The Stellar Tables (Section E) list the mean and apparent places of 176 stars for the current year, along with coefficients for converting from mean to apparent place for any date in the year. The list of stars is essentially the same as that for the star tables on pages 268–273 of the *Nautical Almanac*. The stars are arranged in order of increasing right ascension (decreasing sidereal hour angle), except where both components of a binary system are listed, in which case the brighter component is listed first. For binary stars which can be resolved in small instruments, the position of one or both components is listed rather than the position of the center of gravity or the center of light. For convenience of navigators the sidereal hour angle (SHA) is tabulated rather than right ascension (RA); astronomers can obtain the right ascension in degrees from the relation RA = 360° – SHA.

The quantities tabulated for each star are, from left to right on the page:

(1) An identification number.

(2) The navigational star number, provided the star is one of the 57 selected navigation stars listed in the *Nautical Almanac* and *Air Almanac*.

(3) The star name. The Bayer designation is on the first line and the proper name, if any, is on the second line.

(4) The magnitude and spectral type. The visual magnitude is on the first line and the spectral type is on the second line. A composite spectrum is denoted by *.

(5) The mean place of the star for 1979.0. SHA in degrees is on the first line, and declination in degrees is on the second line.

(6) Four coefficients (H, R, S, C) in degrees for conversion from mean to apparent place. The coefficients on the first line are for the conversion of SHA; these will hereafter be designated H_S, R_S, S_S, C_S. The coefficients on the second line are for the conversion of declination; these will hereafter be designated H_D, R_D, S_D, C_D.

(7) The apparent place of the star for 1979.5. SHA in degrees is on the first line, and declination in degrees is on the second line.

The mean place of a star is to be regarded as a fundamental reference point with no simple geometric or observational significance. The apparent place of a star is the geocentric position, referred to the true equator and equinox of date, at which the star is observed. The apparent place is the position needed for navigational purposes, calibration of telescope setting circles, computation of transit times, *etc.* For work requiring accuracies of no better than ±1.′3, the tabulated apparent place for 1979.5 can be used for any date during the year. To obtain apparent places to greater accuracy, the following procedures should be used:

For the desired date in 1979, determine τ, the fraction of the year elapsed. If the day of the year is t, τ can be computed from the quantities A and B listed at the beginning of the table: $\tau = t/A + B$.

Star positions accurate to better than ±0′.5 can then be obtained by using the following formulas:

$$\text{apparent SHA} = \text{mean SHA} + H_S + R_S\tau$$
$$\text{apparent decl.} = \text{mean decl.} + H_D + R_D\tau$$

Star positions accurate to better than ±0′.1 (and generally better than ±0′.05) can be obtained by using the following formulas:

$$\text{apparent SHA} = \text{mean SHA} + H_S + R_S\tau + S_S \sin 360^\circ\tau + C_S \cos 360^\circ\tau$$
$$\text{apparent decl.} = \text{mean decl.} + H_D + R_D\tau + S_D \sin 360^\circ\tau + C_D \cos 360^\circ\tau$$

The tabulated apparent places for 1979.5 were computed using these latter formulas with $\tau = 0.500$.

Example: Compute the apparent place of Betelgeuse (α Orionis) on 5 March 1979 to an accuracy of 0′.1.

From the calendar on pages A2–A4 or the algorithm on pages B1–B2, 5 March is found to be day 64. From page E3, A = 365.0000 and B = –0.0027. Therefore τ = 64 / 365.0000 – 0.0027 = 0.1726 and $360^\circ\tau$ = 62°.15. Using the data for Betelgeuse on page E4 (Betelgeuse is star 42), we find:

Mean SHA	271°.4913	Mean decl.	+ 7°.4042
$+ H_S$	+ 0.0007	$+ H_D$	– 0.0025
$+ R_S\tau$	– 0.0021	$+ R_D\tau$	+ 0.0001
$+ S_S \sin 360^\circ\tau$	+ 0.0010	$+ S_D \sin 360^\circ\tau$	+ 0.0014
$+ C_S \cos 360^\circ\tau$	– 0.0026	$+ C_D \cos 360^\circ\tau$	– 0.0001
Apparent SHA	271°.4883	Apparent decl.	+ 7°.4031

Section B: APPLICATIONS

Introduction

In this section reference will be made to the following functions:

Sign function. The sign function serves to extract the algebraic sign from a number. The notation sign(x) is defined to be sign(x) = 1 for $x \geqslant 0$, sign(x) = −1 for $x < 0$. An equivalent definition is sign(x) = $x/|x|$ for $x \neq 0$, sign(x) = 1 for $x = 0$.
Examples: sign(247) = 1, sign(−6.28) = −1.

Truncation or largest-integer function. The truncation function extracts the intetral part of a number. The algebraic sign of the result is the same as that of the original number. $\langle x \rangle$ is defined to be $\langle x \rangle = \text{sign}(x) \cdot N$, where N is the largest nonnegative integer such that $N \leqslant |x|$.
Examples: $\langle 17.835 \rangle = 17$, $\langle -3.1416 \rangle = -3$.

Modulus or remainder function. The modulus function yields the remainder of the division x/y, when the quotient is constrained to be an integral value. Thus mod(x,y) is defined to be $\text{mod}(x,y) = x - \langle x/y \rangle \cdot y$.
Examples: mod(11,3) = 2, mod(−764.3,360.0) = −44.3.
Note that $\langle x \rangle = x - \text{mod}(x,1.0)$. Therefore the truncation function can be defined in terms of the modulus function and *vice versa*. If either modulus or truncation is available on a calculator or computer, the other function can be simply obtained.

In this almanac Universal Time (UT) is to be identified with UT1, which is equivalent to the standard navigational time argument Greenwich Mean Time (GMT). The symbols UT and GMT may therefore be considered interchangable. For detailed information on time systems the reader should consult the Explanation of a current edition of the *American Ephemeris and Nautical Almanac*.

Day of the Year

The day of the year, N, is defined as the integer $N = \langle t \rangle$, where t is the time elapsed in days since 0 January, 0^h UT, of the current year. Thus N takes on integer values between 1 and 365 (or 366 in leap years). The day of the year can be computed from either of the following formulas:

$$N = \left\langle \frac{275M}{9} \right\rangle - \left\langle \frac{M+9}{12} \right\rangle \cdot \left(1 + \left\langle \frac{K - 4\langle K/4 \rangle + 2}{3} \right\rangle\right) + I - 30$$

$$N = \left\langle \frac{275M}{9} \right\rangle - \left\langle \frac{M+9}{12} \right\rangle \cdot \left(1 + \left\langle \frac{\text{mod}(K,4) + 2}{3} \right\rangle\right) + I - 30$$

where N is the day of the year, K is the year (*e.g.*, 1978), M is the month ($1 \leqslant M \leqslant 12$), and I is the day of the month ($1 \leqslant I \leqslant 31$).

These formulas are equivalent and are valid for any year, except those century years that are not evenly divisible by 400. Therefore the formulas given

above are valid for the year 2000, but not for 1900 or 2100. In the above formulas the factor within the parentheses has the value 1 for leap years and 2 for non-leap years. Thus for a non-leap year, the following expression can be used:

$$N = \left\langle \frac{275M}{9} \right\rangle - 2\left\langle \frac{M+9}{12} \right\rangle + I - 30$$

For leap years the equivalent expression is

$$N = \left\langle \frac{275M}{9} \right\rangle - \left\langle \frac{M+9}{12} \right\rangle + I - 30$$

Many expressions in this almanac require the value of t, the time elapsed in days since 0 January, 0^h UT, of the current year. By inverting the definition of N, we obtain $t = N + \mathrm{UT}/24$, where UT is the Universal Time expressed in hours.

Julian Date

The Julian Date (JD) is a continuous count of days and fractions thereof from 1 January 4713 B.C. (=−4712 January 1), Greenwich Mean Noon (=12^h UT). For example A.D. 1978 January 1, 0^h UT, is JD 2443509.5 and A.D. 1978 July 21, 15^h UT, is JD 2443711.125. Conversion of Gregorian Calendar Date to Julian Date for the years A.D. 1801 through A.D. 2099 can be carried out with the following formula:

$$\begin{aligned} \mathrm{JD} = {} & 367K - \left\langle \frac{7(K + \langle (M+9)/12 \rangle)}{4} \right\rangle + \left\langle \frac{275M}{9} \right\rangle + I + 1721013.5 \\ & + \mathrm{UT}/24 - 0.5\,\mathrm{sign}(100K + M - 190002.5) + 0.5 \end{aligned}$$

where K is the year ($1801 \leqslant K \leqslant 2099$), M is the month ($1 \leqslant M \leqslant 12$), I is the day of the month ($1 \leqslant I \leqslant 31$), and UT is the Universal Time in hours. The last two terms in the formula add up to zero for all dates after 1900 February 28, so these two terms can be omitted for subsequent dates. Note that the formula makes use of the truncation and sign functions defined on page B1.

Example: Compute the JD corresponding to 1877 August 11, 7^h30^m UT.

Substituting $K = 1877$, $M = 8$, $I = 11$, and $\mathrm{UT} = 7.5$ in the formula yields

$$\begin{aligned} \mathrm{JD} & = 688859 - 3286 + 244 + 11 + 1721013.5 + 0.3125 + 0.5 + 0.5 \\ & = 2406842.8125 \end{aligned}$$

The Modified Julian Date (MJD) is sometimes used to specify current dates; it is defined as MJD = JD − 2400000.5. Use of the Modified Julian Date, rather than the Julian Date, is recommended with computers and calculators of limited precision. Note that for 0^h UT on any date the Julian Date has a fractional part of .5, while the corresponding Modified Julian Date is an integer.

If ephemeris time (ET) is used in the above formula instead of Universal Time (UT), the resulting quantity is designated Julian Ephemeris Date (JED).

Sidereal Time

The following formulas are relevant to the computation of sidereal time:

(1) $\text{GMST} = 6^{\text{h}}.60444111 + 0^{\text{h}}.0657098232N + 1.0027379093\text{UT}$

(2) $\text{GMST} = 6^{\text{h}}.67170278 + 0^{\text{h}}.0657098232(\text{JD0} - 2433282.5) + 1.0027379093\text{UT}$

(3) $\Omega = 171^{\circ}.2785 - 0^{\circ}.0529539(N + \text{UT}/24)$

(4) $\Omega = 372^{\circ}.1133 - 0^{\circ}.0529539(\text{JD} - 2433282.5)$

(5) $E = -0^{\text{h}}.00029 \sin\Omega$

(6) $\text{GAST} = \text{GMST} + E$

(7) $\text{GAST} = \Sigma(t_0) + 1.0027379093\text{UT} = \Sigma(t) + \text{UT}$

(8) $\text{LAST} = \text{GAST} - \lambda/15$

where

GMST is the Greenwich mean sidereal time in hours;
Ω is the mean longitude of the ascending node of the Moon's orbit, measured in degrees;
E is the equation of the equinoxes in hours;
GAST is the Greenwich apparent sidereal time in hours;
LAST is the local apparent sidereal time in hours;
N is the day of the year ($1 \leqslant N \leqslant 365$ or, during a leap year, $1 \leqslant N \leqslant 366$);
UT is the Universal Time in hours;
JD0 and JD are the Julian Dates at 0^{h} UT of the day of interest and at the instant of interest, respectively;
$\Sigma(t_0)$ and $\Sigma(t)$ are values obtained by evaluating the Chebyshev series for Apparent Sidereal Time (pp. D1–D4 or E1) at 0^{h} UT of the day of interest and at the instant of interest, respectively;
λ is the local longitude in degrees (west is positive; east is negative).

When using the above formulas, it may be necessary to reduce the resulting hour values to the range 0^{h}–24^{h} by adding or subtracting multiples of 24^{h}.

Formulas (1) and (3) are specifically for the current year; the other formulas are valid at least over the latter half of this century. Formula (5) is an approximation that is accurate to about $\pm 0^{\text{s}}.2$. If more accuracy is required, the Chebyshev series for the Equation of the Equinoxes (pp. D1–D4 or E1) can be used in place of Formula (5). If sidereal time is to be computed to an accuracy better than $\pm 0^{\text{s}}.2$ (rarely justified for practical applications), then *either* the Chebyshev series for the Equation of the Equinoxes should be used in place of Formula (5) *or* Formula (7) should be used in place of Formula (6).

The above formulas can be easily adapted to allow the Modified Julian Date to be used in place of the Julian Date.

Hour Angles

The following formulas are useful if astronomical data, such as that given in Sections C and E, are applied to navigational purposes:

$$\mathrm{GHA} = 15(\mathrm{GAST} - \mathrm{RA})$$

$$\mathrm{LHA} = 15(\mathrm{LAST} - \mathrm{RA}) = \mathrm{GHA} - \lambda$$

$$\mathrm{GHA\ Aries} = 15\,\mathrm{GAST}$$

$$\mathrm{SHA} = 360^\circ - 15\,\mathrm{RA}$$

$$\mathrm{GHA} = \mathrm{GHA\ Aries} + \mathrm{SHA}$$

where

GHA is the Greenwich hour angle in degrees;
LHA is the local hour angle in degrees;
GHA Aries is the Greenwich hour angle of the First Point of Aries (the origin of right ascension) in degrees;
SHA is the sidereal hour angle in degrees;
RA is the apparent right ascension (referred to the true equator and equinox of date) in hours;
λ is the local longitude in degrees (west is positive; east is negative)
GAST is the Greenwich apparent sidereal time in hours;
LAST is the local apparent sidereal time in hours.

When using the above formulas, it may be necessary to add or subtract 360° to reduce the resulting hour angles to the range 0°–360°. Often local hour angle values are reduced to the range −180° to +180°, in which case they are called meridian angles. In all cases positive hour angle values are measured westward from the meridian.

Altitude and Azimuth

The following formulas can be used to compute the altitude (a) and azimuth (A) of a celestial body:

(1) $\sin a = \cos z = \sin\phi \sin\delta + \cos\phi \cos\delta \cos \mathrm{LHA}$

(2) $\tan x = (-\cos\delta \sin \mathrm{LHA}) / (\cos\phi \sin\delta - \sin\phi \cos\delta \cos \mathrm{LHA})$

$A = 360^\circ + x$ if in Eq. (2) the denominator is positive and the numerator is negative;
$A = x$ if both the denominator and numerator in Eq. (2) are positive;
$A = 180^\circ + x$ if the denominator of Eq. (2) is negative;

where

a is the altitude of the body above the horizon;

x is an auxiliary angle in the range $-90° \leq x \leq +90°$;

A is the azimuth of the body measured East from North over the range $0° \leq A \leq 360°$;

ϕ is the observer's latitude (north is positive; south is negative);

δ is the declination of the body (north is positive; south is negative);

LHA is the local hour angle of the body;

z is the zenith distance of the body ($z = 90° - a$).

If the computed value of $\sin a$ is negative, the body is below the horizon. The standard navigational notation for altitude is Hc, and the navigational notation for azimuth is Zn. Equations (1) and (2) are the basic expressions used in preparing Sight Reduction Tables.

Sunrise, Sunset and Twilight

The following algorithm provides a means of computing times of sunrise, sunset and twilight for the current year for specified locations. Between latitudes 65° North and 65° South the phenomena can be computed to an accuracy of $\pm 2^m$. Although the algorithm can be used at higher latitudes, its accuracy deteriorates near dates on which the Sun remains above or below the horizon for more than twenty-four hours.

Notation:
- ϕ = latitude of observer (north is positive; south is negative)
- λ = longitude of observer (west is positive; east is negative)
- M = Sun's mean anomaly
- L = Sun's true longitude
- α = Sun's right ascension
- δ = Sun's declination
- H = Sun's local hour angle
- z = Sun's zenith distance at rise, set or twilight*
- t = approximate time of phenomenon in days since 0 Jan., 0^hUT
- T = local mean time of phenomenon
- UT = Universal Time of phenomenon

*The proper value of z should be chosen from the following:

	z	$\cos z$
Sunrise and Sunset	90°50′	−0.01454
Civil Twilight	96°	−0.10453
Nautical Twilight	102°	−0.20791
Astronomical Twilight	108°	−0.30902

Formulas for 1978:

(1) $M = 0\overset{\circ}{.}985600t - 3\overset{\circ}{.}507$

(2) $L = M + 1\overset{\circ}{.}916 \sin M + 0\overset{\circ}{.}020 \sin 2M + 282\overset{\circ}{.}588$

(3) $\tan \alpha = 0.91746 \tan L$

(4) $\sin \delta = 0.39782 \sin L$

(5) $\cos H = (\cos z - \sin \delta \sin \phi)/(\cos \delta \cos \phi)$

(6) $T = H + \alpha - 0\overset{h}{.}065710t - 6\overset{h}{.}604$

(7) $UT = T + \lambda$

Procedure:

1. With an initial value of t, compute M from Eq. (1) and then L from Eq. (2). If a morning phenomenon (sunrise or the beginning of morning twilight) is being computed, construct an initial value of t from the formula
$$t = N + (6^h + \lambda)/24$$
where N is the day of the year (see the calendar on pages A2–A4 or the formulas on page B1) and λ is the observer's longitude expressed in hours. If an evening phenomenon is being computed, use
$$t = N + (18^h + \lambda)/24$$
2. Solve Eq. (3) for α, noting that α is in the same quadrant as L. Transform α to hours for later use in Eq. (6).
3. Solve Eq. (4) for $\sin \delta$ which appears in Eq. (5); $\cos \delta$, which also is required in Eq. (5), should be determined from $\sin \delta$. While $\sin \delta$ may be positive or negative, $\cos \delta$ is always positive.
4. Solve Eq. (5) for H. Since computers and calculators normally give the arccosine in the range 0°–180°, the correct quadrant for H can be selected according to the following rules:
   (a) rising phenomena, $H = 360° - \arccos H$;
   (b) setting phenomena, $H = \arccos H$.
   In other words, for rising phenomena H must be either in quadrant 3 or 4 (depending on the sign of $\cos H$), whereas H must be either in quadrant 1 or 2 for setting phenomena. Convert H from degrees to hours for use in Eq. (6).
5. Compute T from Eq. (6), recalling that H and α must be expressed in hours. If T is negative or greater than 24^h, it should be converted to the range 0^h–24^h by adding or subtracting multiples of 24^h.
6. Compute UT from Eq. (7), where λ must be expressed in hours. UT is an approximation to the time of sunrise, sunset or twilight, referred to the Greenwich meridian. If UT is greater than 24^h, the phenomenon occurs on the following day, Greenwich time. If UT is negative, the phenomenon occurs on the previous day, Greenwich time.

To ensure that precision is not lost during the computations, t should be carried to four decimal places. Angles should be expressed to three decimals of a degree and, upon conversion, to three decimals of an hour. Five significant digits should be carried for the trigonometric functions.

Under certain conditions Eq. (5) will yield a value of $|\cos H| > 1$. This mathematical embarrassment indicates the absence of the phenomenon on that day. At far northern latitudes, for example, there is continuous illumination during certain summer days and continuous darkness during winter days.

Example: Compute the time of sunset on 4 July at Washington, D.C.

Latitude = 38°54′ North Longitude = 77°04′ West

$\lambda = +77\overset{\circ}{.}067/15 = +5\overset{h}{.}138$

$\phi = +38\overset{\circ}{.}9$ $\sin\phi = 0.62796$ $\cos\phi = 0.77824$

For sunset: $z = 90°50'$ $\cos z = -0.01454$

$t = 185^d + (18^h + 5\overset{h}{.}138)/24 = 185\overset{d}{.}9641$

$M = 0\overset{\circ}{.}985600(185.9641) - 3\overset{\circ}{.}507 = 179\overset{\circ}{.}779$

$L = 179\overset{\circ}{.}779 + 1\overset{\circ}{.}916(-0.00385) + 0\overset{\circ}{.}020(0.00771) + 282\overset{\circ}{.}588$

$= 462\overset{\circ}{.}360 = 102\overset{\circ}{.}360$

$\tan a = 0.91746(-4.56345) = -4.18678$

$a = 103\overset{\circ}{.}433 = 6\overset{h}{.}896$ Since L is in quadrant 2, so is a.

$\sin\delta = 0.39782(0.97682) = 0.38860$

$\cos\delta = 0.92141$

$\cos H = [-0.01454 - (0.38860)(0.62796)]/[(0.92141)(0.77824)]$

$= -0.36058$

Since sunset is being computed and $\cos H$ is negative, H is in the second quadrant: $H = 111\overset{\circ}{.}136 = 7\overset{h}{.}409$

$T = 7\overset{h}{.}409 + 6\overset{h}{.}896 - 0\overset{h}{.}065710(185.9641) - 6\overset{h}{.}604 = -4\overset{h}{.}519$

$= 19\overset{h}{.}481$

$UT = 19\overset{h}{.}481 + 5\overset{h}{.}138 = 24\overset{h}{.}619$

Sunset occurred at $0^h 37^m$ UT on 5 July = $20^h 37^m$ EDT on 4 July.

Example: Compute the beginning of nautical twilight on 12 January at latitude 62°.5 South, longitude 7°.0 East.

$\lambda = -7\overset{\circ}{.}0/15 = -0\overset{h}{.}467$

$\phi = -62\overset{\circ}{.}5$ $\sin\phi = -0.88701$ $\cos\phi = 0.46175$

For nautical twilight: $z = 102°$ $\cos z = -0.20791$

$t = 12^d + (6^h - 0\overset{h}{.}467)/24 = 12\overset{d}{.}2305$

$M = 0\overset{\circ}{.}985600(12.2305) - 3\overset{\circ}{.}507 = 8\overset{\circ}{.}547$

$L = 8\overset{\circ}{.}547 + 1\overset{\circ}{.}916(0.14862) + 0\overset{\circ}{.}020(0.29394) + 282\overset{\circ}{.}588$

$= 291\overset{\circ}{.}426$

$\tan a = 0.91746(-2.54829) = -2.33795$

$a = 293\overset{\circ}{.}158 = 19\overset{h}{.}544$ Since L is in quadrant 4, so is a.

$\sin\delta = 0.39782(-0.93089) = -0.37033$

$\cos\delta = 0.92890$

$\cos H = [-0.20791 - (-0.37033)(-0.88701)]/[(0.92890)(0.46175)]$

$= -1.25058$

Since the computed absolute value of $\cos H$ is greater than 1, there is no beginning time for morning nautical twilight on this date.

Moonrise and Moonset

Times of moonrise and moonset can be computed for specified locations using the following algorithm. Between latitudes 60° North and 60° South, the phenomena can be computed to an accuracy of $\pm 5^{m}$. Although the algorithm can be used at higher latitudes, its accuracy deteriorates near dates on which the Moon remains above or below the horizon for more than twenty-four hours.

Notation: ϕ = latitude of observer (north is positive; south is negative)
λ = longitude of observer (west is positive; east is negative)
t_i = *i-th* approximation to Universal Time of phenomenon, expressed in days from 0 January, 0^{h} UT
GHA_i = Moon's GHA at time t_i
δ_i = Moon's declination at time t_i (north is positive; south is negative)
τ_i = *i-th* correction to t_0, thus $t_i = t_0 + \tau_i$
H_i = *i-th* approximation to Moon's LHA at time of rise or set
ΔH_i = *i-th* approximation to Moon's daily rate of change in GHA

Formulas:

(1) $\Delta H_i = (GHA_i - GHA_0)/\tau_i$ for $i = 0$, let $\Delta H_0 = 347\overset{\circ}{.}81$
(2) $\cos H_{i+1} = (0\overset{\circ}{.}00233 - \sin\phi \sin\delta_i)/(\cos\phi \cos\delta_i)$
(3) $\tau_{i+1} = (H_{i+1} - H_0)/\Delta H_i$
(4) $t_{i+1} = t_0 + \tau_{i+1}$

Procedure:

1. Let $t_0 = N + (12^{h} + \lambda)/24$, where N is the day of the year (see the calendar on pages A2–A4 or the formulas on page B1) and λ is the observer's longitude expressed in hours. Set $i = 0$ and begin the following iterative process.
2. For time t_i compute the Moon's GHA and declination to navigational precision ($\pm 0\overset{'}{.}1$). Label these quantities GHA_i and δ_i, respectively, where i specifies the iteration number. For $i = 0$, compute $H_0 = GHA_0 - \lambda$.
3. If $i = 0$, let $\Delta H_0 = 347\overset{\circ}{.}81$. Otherwise compute ΔH_i from Eq. (1). If $\Delta H_i < 0$, add $360°/|\tau_i|$ to ΔH_i.
4. Solve Eq. (2) for H_{i+1}. Since computers and calculators normally give the arccosine in the range 0°–180°, the correct quadrant for H_{i+1} can be selected according to the following rules:
   (a) moonrise computations, $H_{i+1} = 360° - \arccos H_{i+1}$;
   (b) moonset computations, $H_{i+1} = \arccos H_{i+1}$.
   In other words, near the time of moonrise H_{i+1} must be either in quadrant 3 or 4 (depending on the sign of $\cos H_{i+1}$); near moonset H_{i+1} must be either in quadrant 1 or 2. For latitudes higher than 60° (*i.e.*, $|\phi| > 60°$), the condition $|\cos H_{i+1}| > 1$ can occur, thereby indicating the absence of the phenomenon on that day.

5. Compute τ_{i+1} from Eq. (3). If $|\tau_{i+1}| < 0\overset{d}{.}5$, proceed to Step 6. If $|\tau_{i+1}| > 0\overset{d}{.}5$, the phenomenon being computed occurs on the day prior to the day desired (if τ_{i+1} is negative) or on the day following the day desired (if τ_{i+1} is positive). Normally the phenomenon on the desired day can be obtained by adding to τ_{i+1} (if τ_{i+1} is negative), or subtracting from τ_{i+1} (if τ_{i+1} is positive), $360°/\Delta H_i$. If successful this technique will produce a new value of τ_{i+1} in the required range. However, two conditions may prevent the reduction to $|\tau_{i+1}| < 0\overset{d}{.}5$:
   (a) for low values of i, τ_{i+1} may be a fairly crude approximation to the ultimate value, τ_n;
   (b) each month there is one day (near last quarter) on which there is no moonrise, and another day (near first quarter) on which there is no moonset.

   If $|\tau_{i+1}| \approx 0\overset{d}{.}5$, it is probably worth attempting another iteration to see if $|\tau_{i+2}| < 0\overset{d}{.}5$.
6. Compute t_{i+1} from Eq. (4). If $|t_{i+1} - t_i| < 0\overset{d}{.}01$, t_{i+1} is accurate to $\pm 5^m$. Otherwise it is necessary to iterate the solution by setting $i = i + 1$ and executing Steps 2 through 6 again.

Example: Compute the time of moonrise on 19 April 1979 at latitude 42°05′ North and longitude 92°54′ West.

$\phi = +42\overset{\circ}{.}083 \qquad \sin\phi = 0.67021 \qquad \cos\phi = 0.74217$

$\lambda = +92\overset{\circ}{.}900 = +6\overset{h}{.}193$

From the calendar on pages A2–A4 or the formulas on pages B1–B2, 19 April is found to be day 109; therefore

$t_0 = 109^d + (12^h + 6\overset{h}{.}193)/24 = 109\overset{d}{.}75804$

$i = 0$:

$GHA_0 = 179\overset{\circ}{.}909 \qquad \delta_0 = -16\overset{\circ}{.}621$

$H_0 = 179\overset{\circ}{.}909 - 92\overset{\circ}{.}900 = 87\overset{\circ}{.}009$

$\Delta H_0 = 347\overset{\circ}{.}81$

$\cos H_1 = [0.00233 - (0.67021)(-0.28604)]/[(0.74217)(0.95822)]$
$= 0.27284$

Since moonrise is sought, H_1 is in quadrant 3 or 4: $H_1 = 285\overset{\circ}{.}834$

$\tau_1 = (285\overset{\circ}{.}834 - 87\overset{\circ}{.}009)/347\overset{\circ}{.}81 = 0\overset{d}{.}57165$

Since $|\tau_1| > 0\overset{d}{.}5$, we try

$\tau_1 = 0\overset{d}{.}57165 - 360°/347\overset{\circ}{.}81 = -0\overset{d}{.}46340$, which is satisfactory.

$t_1 = 109\overset{d}{.}75804 - 0\overset{d}{.}46340 = 109\overset{d}{.}29464 =$ 19 April 07^h04^m UT
$=$ 19 April 01^h04^m, 90th Meridian West

$i = 1$:

$GHA_1 = 19\overset{\circ}{.}381 \qquad \delta_1 = -17\overset{\circ}{.}427$

$\Delta H_1 = (19\overset{\circ}{.}381 - 179\overset{\circ}{.}909)/-0\overset{d}{.}46340 = 346\overset{\circ}{.}413$

$\cos H_2 = [0.00233 - (0.67021)(-0.29949)]/[(0.74217)(0.95410)]$
$= 0.28675$

Since moonrise is sought, H_2 is in quadrant 3 or 4: $H_2 = 286\overset{\circ}{.}664$

$\tau_2 = (286^\circ.664 - 87^\circ.009) / 346^\circ.413 = 0^d.57635$

Since $|\tau_2| > 0^d.5$, we try

$\tau_2 = 0^d.57635 - 360^\circ / 346^\circ.413 = -0^d.46287$, which is satisfactory.

$t_2 = 109^d.75804 - 0^d.46287 = 109^d.29517 =$ 19 April 07^h05^m UT

$=$ 19 April 01^h05^m, 90^{th} Meridian West

Since $|t_2 - t_1| = 0^d.0005 < 0^d.01$, t_2 is accurate to $\pm 5^m$.

The extremely rapid convergence illustrated in this example occurs frequently but not invariably. Although the first approximation (t_1) will often give adequate precision for most purposes, it is recommended that the solution be iterated and that the convergence criterion ($|t_{i+1} - t_i| < 0^d.01$) be tested.

Equation of Time

The equation of time, the hour angle of the apparent (true) Sun minus the hour angle of the mean (fictitious) Sun, can be represented to reasonable precision by the following formula:

$$\begin{aligned} \mathrm{EqT} = & -97^s.8 \sin l - 431^s.3 \cos l + 596^s.6 \sin 2l - 1^s.9 \cos 2l \\ & + 4^s.0 \sin 3l + 19^s.3 \cos 3l - 12^s.7 \sin 4l \end{aligned}$$

where EqT is the equation of time in seconds and l is the Sun's mean longitude.

$l = 279^\circ.697 + 0^\circ.98564734(\mathrm{JD} - 2415020.0) = 279^\circ.073 + 0^\circ.98564734t$

In the equation for l, JD is the Julian Date and t is the elapsed time in days and fractions thereof since 0 January 1979, 0^h UT. Formulas for computing JD and t are given on pages B1–B2. Values of l and its multiples may have to be reduced to the range 0°–360° by adding or subtracting multiples of 360°.

The local mean time of solar transit is given by 12^h minus EqT. Thus EqT represents the difference local apparent (sundial) time minus local mean time.

Polaris (Pole Star)

The following formulas are relevant to observations of Polaris:

(1) $\phi = a - p \cos h + 0.5 p \sin p \sin^2 h \tan \phi$

(2) $A \cos \phi = p \sin h + p \sin p \sin h \cos h \tan \phi$

where p is the polar distance of Polaris: $p = 90^\circ -$ declination of Polaris

h is the LHA of Polaris: $h =$ GHA Aries + SHA Polaris + east (−west) longitude of observer

ϕ is the observer's latitude;

A is the azimuth of Polaris;

a is the corrected altitude of Polaris.

Eq. (1) permits the observer's latitude to be determined from an observation of the altitude of Polaris (corrected for refraction, dip, *etc.*). Assumed values of the observer's latitude and longitude can be used for the right side of Eq. (1).

Eq. (2) yields the azimuth of Polaris if the observer's position is known. These expressions are accurate only for Polaris, since they depend on p being a small quantity. The SHA and declination of Polaris to be used in these formulas should be referred to the true equator and equinox of date; *i.e.*, the apparent place of Polaris should be computed (see Section F 'Stellar Tables'; Polaris is star number 17).

Equation of Position Line

The following formula can be used to obtain a line of position (LOP) directly from an observation of the altitude of a celestial body:

$$\lambda = \mathrm{GHA} \pm \arccos[(\sin a - \sin\phi \sin d)/\cos\phi \cos d]$$

where: λ is the computed longitude;
GHA is the GHA of the body for the time of observation;
a is the corrected altitude of the body;
d is the declination of the body for the time of observation;
ϕ is an estimate of the observer's latitude.

North latitudes and west longitudes are positive; south latitudes and east longitudes are negative. Longitudes with absolute values greater than 180° may be encountered. The operation connecting the two terms is + for bodies east of the meridian (rising) and − for bodies west of the meridian (setting).

The formula yields the longitude λ at which the position line crosses the parallel of latitude ϕ. Repeated application of the formula using different latitude values yields a locus of points all lying on the LOP. Note that no assumed position is necessary, although an estimate of the observer's latitude is helpful in reducing the number of times the formula is applied.

The formula becomes indeterminate at the transit time of a body and for latitudes which the position line does not cross at any point.

Motion of Body and Motion of Observer

The following formula gives the change of altitude of a celestial body, due to the rotation of the Earth, in the time interval Δt (*e.g.*, the interval between a sextant observation and the time of a fix). This correction may be applied to the observed altitude to permit the use of a common assumed position and LHA Aries for observations made at different times.

$$MOB = 15.04\, \Delta t \cos\phi \sin A$$

where MOB is the altitude correction in minutes of arc, Δt is the time difference in minutes, ϕ is the latitude of the observer, and A is the azimuth of the observed body. If the time of the fix is later than the time of observation, MOB should be added to the observed altitude.

The following formula gives the change of altitude of a celestial body, due to the motion of the observer, in the time interval Δt (*e.g.*, the interval between a

sextant observation and the time of a fix). This correction may be applied to the altitude in lieu of advancing or retiring a line of position.

$$MOO = \frac{v\,\Delta t}{60}\cos(A - C)$$

where MOO is the altitude correction in minutes of arc, Δt is the time difference in minutes, A is the azimuth of the observed body, C is the track/course angle, and v is the ground speed in knots. If the time of the fix is later than the time of observation, MOO should be added to the observed altitude.

These formulas are approximations; they become unreliable for values of Δt greater than 5 minutes.

Sextant Altitude Corrections

Several corrections must be applied to a sextant altitude (hs) in order to obtain a corrected altitude (Ho). Ho can then be either (a) compared with the computed altitude (Hc) to obtain the altitude difference (Δa); or (b) used in the 'Equation of Position Line' (see page B11) in order to obtain directly the location of the LOP for the sight.

The corrections, in the order in which they should be applied, are:

(1) Instrument and/or index correction, IC;
(2a) Dip of horizon, D (marine sextant);
or
(2b) Coriolis correction, Δz (bubble sextant);
(3) Atmospheric refraction, R;
(4) Semi-diameter, SD (marine sextant, Sun and Moon observations);
(5) Parallax in altitude, PA (Moon, Venus and Mars observations).

In mathematical notation:

$$\text{Ho} = \text{hs} + \text{IC} + (\text{D or } \Delta z) - \text{R} + \text{SD} + \text{PA}$$

If Venus is observed, an additional correction for the phase of the planet may be necessary. This correction can be made either to the sextant altitude or to the GHA or LHA of Venus.

Descriptions and formulas for D, Δz, R, SD, PA and the phase correction for Venus are given in the following pages.

Dip of Horizon

The dip of the apparent horizon from a horizontal plane is given by

$$\text{D} = -0.97\sqrt{h}$$

where h is the height of eye level of the observer in feet and D is the dip of the horizon in minutes of arc. For observations of a celestial body made with a marine sextant or similar instrument, D should be added to the observed altitude to obtain the corrected altitude. This formula is an approximation; the apparent dip varies with atmospheric conditions.

Coriolis Correction

Any object moving across or above the surface of the rotating Earth is subject to an apparent force tending to push the object to the right in the northern hemisphere and to the left in the southern hemisphere. This Coriolis acceleration manifests itself as a deflection of the apparent vertical by an amount Z:

(1) $$Z = 2.62\,V\sin\phi + 0.146\,V^2\sin C\tan\phi - 5.25\,VC'$$

where: Z is the deflection in minutes of arc;
- V is the speed in hundreds of knots;
- ϕ is the latitude;
- C is the true track/course angle;
- C' is the rate of change of true track/course angle in degrees per minute of time.

Usually only the first term on the right of Eq. (1) is significant.

Observations of the altitudes of celestial bodies made with bubble sextants or similar artificial horizon instruments must be corrected for the Coriolis effect. The correction Δz, which can be added to the observed (*e.g.*, bubble sextant) altitude, is given approximately by

(2) $$\Delta z = Z\sin(A - C)$$

where:
- Δz is the altitude correction in minutes of arc;
- Z is the deflection of the vertical determined from Eq. (1);
- A is the azimuth of observed body;
- C is the true track/course angle.

In the northern hemisphere the correction Δz is positive for stars on the right and negative for stars on the left of the aircraft. In the southern hemisphere the correction is negative for stars on the right and positive for stars on the left.

Atmospheric Refraction

The Earth's atmosphere tends to refract light in such a way that celestial bodies appear slightly higher in the sky than they would if there were no atmosphere. The formulas below can be used to determine R, the angle of refraction. R should be subtracted from an observed (*e.g.*, sextant) altitude to obtain the corrected altitude.

(1) $$R = \frac{P}{273 + T}[3.430289(z - \arcsin[0.9986047\sin(0.9967614z)]) - 0.01115929z]$$

(2) $$R = \exp(-h/27000)\tan z = 1/[\exp(h/27000)\tan a]$$

where:
- R is the refraction correction in minutes of arc;
- a is the observed altitude
- z is the observed zenith distance in degrees: $z = 90° - a$

T is the temperature in degrees Celsius;
P is the atmospheric pressure in millibars;
h is the height of the observer above sea level in feet.

Eq. (1) is more suitable for surface observations, while Eq. (2) is more suitable for observations from aircraft. Both formulas are approximations and are not equivalent to a complete theory of refraction. Eq. (2), which should be used only for altitudes greater than 10°, is accurate to about 0′.2. Eq. (1) can be used for all altitudes: for altitudes greater than 15°, it is accurate to 0′.1 or better; for altitudes between 3° and 15°, errors between 0′.1 and 1′.0 may arise; for altitudes less than 3°, errors between 1′ and 3′ may be expected.

Semi-diameter of the Sun and Planets

When not available directly from almanac data, the semi-diameters of the Sun and planets can be computed from

$$\mathrm{SD} = S/d = S\pi/8.794$$

where: SD is the semi-diameter in seconds of arc;
S is the semi-diameter at unit distance (1 AU) in seconds of arc;
d is the geocentric distance in AU;
π is the horizontal parallax in seconds of arc.

The following values of S should be used:

Sun	959″.63	Jupiter	98″.47
Mercury	3.34	Saturn	83.33
Venus	8.41	Uranus	34.28
Mars	4.68	Neptune	36.56

These values apply to the equatorial dimensions of the bodies and do not include any adjustments for irradiation.

Semi-diameter of the Moon

When not available directly from almanac data, the semi-diameter of the Moon can be computed from

$$\mathrm{SD} = 56204.92/d = 0.272476\pi \tag{1}$$

where SD is the semi-diameter in seconds of arc, d is the geocentric distance of the Moon in units of the Earth's equatorial radius, and π is the horizontal parallax of the Moon in seconds of arc.

Computed this way, the semi-diameter applies to a fictitious observer located at the center of the Earth. The observed semi-diameter of the Moon will be slightly greater than the geocentric semi-diameter, since a real observer located on the surface of the Earth will be slightly closer to the Moon (assuming it is above the horizon). For navigational and certain other purposes the *augmented semi-diameter* of the Moon should be used:

(2) $$SD_{aug} = SD[1 + (\sin a)/d]$$

where SD_{aug} is the augmented semi-diameter in seconds of arc, a is the altitude of the Moon (for navigational purposes a = Ho, but hs or Hc can be used instead with negligible error), d is the geocentric distance of the Moon in units of the Earth's equatorial radius, and SD is the geocentric semi-diameter computed from Eq. (1). For navigational purposes a constant value of $d = 60.27$ can be used to sufficient accuracy. The increase in the Moon's semi-diameter due to augmentation is zero when the Moon is on the horizon and is about 0.′3 when the Moon is at the zenith.

Parallax in Altitude

The finite size of the Earth causes a parallactic shift in the apparent positions of nearby celestial objects. The resulting parallax in altitude can be computed from

$$\sin PA = \sin\pi \cos a$$

where PA is the parallax in altitude, π is the horizontal parallax, and a is the observed altitude. When the horizontal parallax of a body is not available, it may be computed from the relation $\pi = 8.''794/d$, where d is the geocentric distance of the body in astronomical units. The parallax in altitude can exceed 1′ only for the Moon. Since parallax tends to decrease the apparent altitude of a body, the quantity PA should be added to an observed (*e.g.*, sextant) altitude in order to obtain the corrected altitude. To a reasonable approximation, PA can also be computed from

$$PA = \pi \cos a$$

Correction for the Phase of Venus

When the altitude of Venus is observed with a small instrument, a correction to the observed altitude is required to account for the fact that the center of light, rather than the center of the disk, is observed. This correction has the form $-k \cos\theta$, where k is a correction factor (given below) and θ is the angle on the celestial sphere, at the position of Venus, between the observer's vertical and the direction of the Sun. The correction, which should be added to the observed (*e.g.*, sextant) altitude, is positive when the Sun is lower than Venus, zero when they have the same altitude, and negative when the Sun is higher.

In sight reduction this effect can be approximately taken into account by correcting the GHA (or LHA) of Venus rather than correcting the observed altitude. Simply add k to the GHA (or LHA) of Venus when Venus is east of the Sun (*i.e.*, when Venus is an evening planet), and subtract k from the GHA (or LHA) when Venus is west of the Sun (morning planet). The correction should not be applied in this way near the time of superior or inferior conjunction.

Venus is at superior conjunction on 25 August 1979. Prior to this date Venus is in the morning sky. Following superior conjunction Venus is in the evening sky.

B16

The values of k for 1979 are:

		k
Jan.	1	0'.2
Jan.	8	0.1
Mar.	1	0.0
Dec.	31	

Section C: NAVIGATIONAL TABLES

DAYS 1 THRU 32 JD 2443874.5 TO 2443906.5 DATES JAN 1 THRU FEB 1

A = 16.00000000 B = -1.06250000

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	6235.8221	6297.5440	-20.8978	0.2717
1	5775.7697	5758.6473	3.0711	0.0
2	-0.0002	0.3619	0.8510	0.0
3	0.0023	0.0377	-0.0606	0.0
4	-0.0001	-0.0074	-0.0069	0.0
5	-0.0019	0.0055	0.0003	0.0
SUMS	12011.5919	12056.5890	-17.0429	0.2717

DAYS 32 THRU 63 JD 2443905.5 TO 2443937.5 DATES FEB 1 THRU MAR 4

A = 16.00000000 B = -3.00000000

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	5906.3771	5936.4716	-12.2645	0.2698
1	5775.7697	5760.2557	5.5586	0.0004
2	-0.0002	0.3707	0.4184	0.0027
3	0.0023	-0.0410	-0.0826	-0.0046
4	-0.0001	-0.0020	0.0003	-0.0017
5	-0.0019	0.0024	0.0050	0.0036
SUMS	11682.1469	11697.0574	-6.3648	0.2702

DAYS 60 THRU 91 JD 2443933.5 TO 2443965.5 DATES MAR 1 THRU APR 1

A = 16.00000000 B = -4.75000000

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	5933.9750	5937.8303	-1.6689	0.2681
1	5775.7720	5761.1477	6.3219	0.0
2	0.0	0.1061	0.0258	0.0041
3	-0.0028	-0.0649	-0.0715	-0.0022
4	0.0	0.0033	0.0022	-0.0039
5	0.0013	0.0026	0.0017	0.0004
SUMS	11709.7455	11699.0251	4.6112	0.2665

DAYS 91 THRU 122 JD 2443964.5 TO 2443996.5 DATES APR 1 THRU MAY 2

A = 16.00000000 B = -6.68750000

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	5964.5298	5940.0515	10.1856	0.2665
1	5775.7702	5760.9491	5.6672	-0.0019
2	-0.0007	-0.2055	-0.3592	-0.0026
3	0.0011	-0.0429	-0.0670	0.0016
4	0.0008	0.0095	0.0011	0.0020
5	-0.0011	-0.0011	0.0020	-0.0005
SUMS	11740.3001	11700.7606	15.4297	0.2651

DAYS 1 THRU 32 JD 2443874.5 TO 2443906.5 DATES JAN 1 THRU FEB 1

A = 16.00000000 B = -1.06250000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	6347.4975	-18.2565	6296.4573	-21.7299	6468.2514	19.6150	6430.3250	8.2744
1	5759.0796	-2.8000	5762.5937	2.3699	5777.9206	0.5484	5776.3566	0.3109
2	-1.1845	0.4415	0.1466	0.5213	0.1096	0.0065	0.1955	0.0742
3	0.1641	0.2131	0.0340	-0.0237	-0.0631	-0.0225	-0.0151	-0.0093
4	-0.0014	-0.0193	-0.0022	-0.0022	-0.0036	-0.0010	-0.0036	-0.0003
5	-0.0024	-0.0023	-0.0044	0.0005	-0.0034	0.0034	0.0018	0.0017
SUMS	12105.5529	-20.4235	12059.2250	-18.8641	12246.2115	20.1498	12206.8602	8.6516

DAYS 32 THRU 63 JD 2443905.5 TO 2443937.5 DATES FEB 1 THRU MAR 4

A = 16.00000000 B = -3.00000000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5982.4342	-20.7838	5942.1990	-15.3839	6142.8721	20.5756	6102.6189	9.0944
1	5756.2886	0.6654	5763.3831	4.0634	5777.5633	0.3907	5776.9017	0.5004
2	-0.2573	1.1743	0.2203	0.3408	-0.2756	-0.0743	0.0742	0.0195
3	0.1705	0.0384	-0.0064	-0.0439	-0.0547	-0.0018	-0.0277	-0.0173
4	0.0015	-0.0242	-0.0009	-0.0049	0.0048	0.0021	-0.0018	-0.0016
5	-0.0072	-0.0024	0.0015	0.0034	0.0021	-0.0043	0.0007	0.0042
SUMS	11738.6303	-18.9323	11705.7966	-11.0251	11920.1120	20.8880	11879.5660	9.5996

DAYS 60 THRU 91 JD 2443933.5 TO 2443965.5 DATES MAR 1 THRU APR 1

A = 16.00000000 B = -4.75000000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5975.9623	-16.0455	5948.7557	-7.4543	5812.5408	21.0083	6132.2697	9.9606
1	5756.6653	4.6297	5764.0748	4.8794	5776.2569	0.0948	5776.8966	0.4554
2	0.3399	0.9780	0.1555	0.1333	-0.4293	-0.0905	-0.0751	-0.3431
3	0.0439	-0.0952	-0.0261	-0.0342	-0.0078	-0.0029	-0.0247	-0.0154
4	-0.0190	-0.0126	-0.0019	-0.0005	0.0064	0.0028	0.0011	0.0007
5	-0.0031	0.0021	0.0035	-0.0020	0.0007	0.0029	-0.0009	0.0049
SUMS	11732.9893	-10.5435	11712.9615	-2.4783	11588.3677	21.0154	11909.0667	10.3631

DAYS 91 THRU 122 JD 2443964.5 TO 2443996.5 DATES APR 1 THRU MAY 2

A = 16.00000000 B = -6.68750000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5970.8028	-4.1998	5957.0761	2.2243	5842.4461	20.8676	5804.5588	10.6207
1	5757.8766	7.1604	5764.4316	4.9737	5774.6502	-0.2348	5776.3623	0.2034
2	0.1516	0.3067	0.0241	-0.0793	-0.3777	-0.0812	-0.1871	-0.0800
3	-0.0809	-0.1238	-0.0166	-0.0419	0.0167	0.0038	-0.0171	-0.0027
4	-0.0046	-0.0026	0.0036	-0.0011	0.0030	0.0012	0.0016	-0.0002
5	0.0011	-0.0002	-0.0028	0.0056	0.0011	-0.0013	0.0034	-0.0014
SUMS	11728.7466	3.1407	11721.5160	7.0813	11616.7394	20.5553	11580.7219	10.7398

DAYS 121 THRU 152 JD 2443994.5 TO 2444026.5 DATES MAY 1 THRU JUNE 1

A = 16.00000000 B = -8.56250000

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
TERM	DEG	DEG	DEG	DEG
0	5994.0992	5940.9244	19.1397	0.2642
1	5775.7686	5759.9199	3.6773	-0.0033
2	-0.0001	-0.3067	-0.6914	0.0
3	0.0043	0.0101	-0.0559	0.0061
4	0.0001	0.0123	0.0033	0.0
5	-0.0027	-0.0004	0.0036	-0.0037
SUMS	11769.8694	11700.5596	22.0766	0.2633

DAYS 152 THRU 183 JD 2444025.5 TO 2444057.5 DATES JUNE 1 THRU JULY 2

A = 16.00000000 B = -10.50000000

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
TERM	DEG	DEG	DEG	DEG
0	6024.6542	5939.8499	23.3536	0.2633
1	5775.7708	5759.1420	0.5525	0.0
2	-0.0019	-0.0560	-0.8806	0.0
3	-0.0044	0.0593	-0.0144	0.0
4	0.0019	0.0088	0.0088	0.0
5	0.0040	0.0030	0.0052	0.0
SUMS	11800.4246	11699.0070	23.0251	0.2633

DAYS 182 THRU 213 JD 2444055.5 TO 2444087.5 DATES JULY 1 THRU AUG 1

A = 16.00000000 B = -12.37500000

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
TERM	DEG	DEG	DEG	DEG
0	6054.2233	5938.5038	21.3352	0.2633
1	5775.7720	5759.6304	-2.6348	0.0
2	0.0	0.2668	-0.7718	0.0
3	-0.0028	0.0325	0.0394	0.0
4	0.0	-0.0029	0.0037	0.0
5	0.0013	0.0010	0.0011	0.0
SUMS	11829.9938	11698.4316	17.9728	0.2633

DAYS 213 THRU 244 JD 2444086.5 TO 2444118.5 DATES AUG 1 THRU SEPT 1

A = 16.00000000 B = -14.31250000

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
TERM	DEG	DEG	DEG	DEG
0	6084.7781	5938.9424	13.6827	0.2633
1	5775.7702	5760.8218	-5.0632	-0.0007
2	-0.0006	0.2702	-0.4633	0.0004
3	0.0009	-0.0292	0.0595	0.0031
4	0.0008	-0.0019	0.0005	0.0006
5	-0.0009	0.0013	0.0005	-0.0015
SUMS	11860.5485	11700.0046	8.2167	0.2652

DAYS 121 THRU 152 JD 2443994.5 TO 2444026.5 DATES MAY 1 THRU JUNE 1

A = 16.00000000 B = -8.56250000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5966.7619	9.4684	5965.3581	11.0467	5868.7283	20.1573	5834.5252	10.7062
1	5757.4691	6.9728	5764.3396	4.3297	5773.4623	-0.5167	5775.5883	-0.1137
2	-0.3816	-0.4091	-0.0702	-0.2576	-0.2539	-0.0690	-0.2104	-0.0820
3	-0.0812	-0.1384	-0.0073	-0.0314	0.0231	-0.0012	0.0101	0.0033
4	0.0094	-0.0038	0.0036	0.0023	-0.0011	-0.0020	0.0027	-0.0009
5	-0.0027	0.0055	-0.0025	0.0029	-0.0016	0.0021	-0.0060	-0.0009
SUMS	11723.7749	15.8954	11729.6213	15.0926	11641.9571	19.5705	11609.9099	10.5120

DAYS 152 THRU 183 JD 2444025.5 TO 2444057.5 DATES JUNE 1 THRU JULY 2

A = 16.00000000 B = -10.50000000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5959.9777	20.4629	5973.4661	18.2853	5894.0090	18.9003	5863.9784	10.1914
1	5755.4039	3.8843	5764.0198	3.0568	5772.7104	-0.7737	5774.8365	-0.4084
2	-0.5546	-1.1658	-0.0808	-0.3914	-0.1402	-0.0631	-0.1676	-0.0689
3	0.0542	-0.1104	0.0145	-0.0181	0.0135	-0.0033	0.0125	0.0022
4	0.0277	0.0102	0.0061	0.0025	0.0006	0.0010	-0.0032	0.0019
5	-0.0003	0.0004	-0.0033	-0.0009	0.0021	0.0045	-0.0011	0.0016
SUMS	11714.9086	23.0816	11737.4224	20.9342	11666.5954	18.0657	11638.6555	9.7198

DAYS 182 THRU 213 JD 2444055.5 TO 2444087.5 DATES JULY 1 THRU AUG 1

A = 16.00000000 B = -12.37500000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5950.0681	23.0814	5980.8303	22.5481	5917.4603	17.2493	5891.2620	9.2143
1	5754.4833	-1.2777	5763.8965	1.4594	5772.3626	-0.9772	5774.2994	-0.6198
2	0.1514	-1.4538	0.0243	-0.4439	-0.0501	-0.0445	-0.1135	-0.0448
3	0.1545	0.0274	0.0278	-0.0111	0.0112	0.0131	0.0129	0.0048
4	-0.0048	0.0223	0.0038	-0.0001	0.0	0.0004	-0.0007	0.0
5	-0.0071	-0.0014	0.0005	0.0075	0.0028	-0.0074	-0.0017	-0.0006
SUMS	11704.8454	20.3982	11744.7832	23.5599	11689.7868	16.2337	11665.4584	8.5539

DAYS 213 THRU 244 JD 2444086.5 TO 2444118.5 DATES AUG 1 THRU SEPT 1

A = 16.00000000 B = -14.31250000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5940.8127	15.6161	5988.6927	23.7167	5941.3244	15.2223	5918.6201	7.8772
1	5756.2262	-6.0774	5764.3251	-0.2214	5772.3190	-1.1042	5773.9795	-0.7445
2	0.5576	-0.9216	0.1929	-0.4015	0.0234	-0.0190	-0.0508	-0.0223
3	-0.0312	0.1382	0.0293	0.0156	0.0167	0.0134	0.0176	0.0031
4	-0.0216	0.0040	-0.0002	0.0022	0.0029	-0.0006	-0.0001	0.0019
5	0.0067	-0.0072	0.0009	0.0	-0.0027	-0.0058	-0.0049	0.0011
SUMS	11697.5504	8.7521	11753.2407	23.1116	11713.6837	14.1061	11692.5614	7.1165

POWER SERIES APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1979

DAYS 244 THRU 275   JD 2444117.5 TO 2444149.5   DATES SEPT 1 THRU OCT 2

A = 16.00000000   B = -16.25000000

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
TERM	DEG	DEG	DEG	DEG
0	6115.3329	5941.2896	2.5749	0.2651
1	5775.7697	5761.4215	-6.1742	0.0019
2	0.0002	0.0026	-0.1058	0.0026
3	0.0024	-0.0533	0.0641	-0.0016
4	0.0001	0.0014	-0.0013	-0.0020
5	-0.0019	-0.0002	-0.0010	0.0005
SUMS	11891.1034	11702.6616	-3.6433	0.2665

DAYS 274 THRU 305   JD 2444147.5 TO 2444179.5   DATES OCT 1 THRU NOV 1

A = 16.00000000   B = -18.12500000

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
TERM	DEG	DEG	DEG	DEG
0	6144.9025	5943.6057	-8.9497	0.2675
1	5775.7686	5760.8437	-5.8829	0.0033
2	-0.0001	-0.3137	0.2719	0.0
3	0.0043	-0.0500	0.0736	-0.0061
4	0.0001	0.0062	0.0014	0.0
5	-0.0027	0.0042	-0.0004	0.0037
SUMS	11920.6727	11704.0961	-14.4861	0.2684

DAYS 305 THRU 336   JD 2444178.5 TO 2444210.5   DATES NOV 1 THRU DEC 2

A = 16.00000000   B = -20.06250000

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
TERM	DEG	DEG	DEG	DEG
0	5815.4575	5943.8008	-18.7795	0.2701
1	5775.7685	5759.2535	-3.9821	-0.0007
2	0.0002	-0.4533	0.7066	-0.0004
3	0.0043	0.0306	0.0799	0.0031
4	-0.0006	0.0165	0.0005	-0.0006
5	-0.0022	-0.0083	-0.0052	-0.0015
SUMS	11591.2277	11702.6398	-21.9798	0.2700

DAYS 334 THRU 365   JD 2444207.5 TO 2444239.5   DATES NOV 30 THRU DEC 31

A = 16.00000000   B = -21.87500000

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
TERM	DEG	DEG	DEG	DEG
0	5844.0406	5941.2094	-23.2762	0.2718
1	5775.7708	5758.0677	-0.8085	-0.0004
2	0.0036	-0.1430	0.9925	-0.0027
3	-0.0028	0.0940	0.0207	0.0046
4	-0.0032	0.0112	-0.0118	0.0017
5	0.0026	0.0004	-0.0003	-0.0036
SUMS	11619.8116	11699.2397	-23.0836	0.2714

DAYS 244 THRU 275 JD 2444117.5 TO 2444149.5 DATES SEPT 1 THRU OCT 2

A = 16.00000000 B = -16.25000000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5935.1543	1.3695	5997.9893	21.9196	5965.3846	13.0567	5945.6004	6.3945
1	5757.6029	-8.1141	5765.3486	-1.5488	5772.5651	-1.1117	5773.9123	-0.7682
2	0.0616	-0.1244	0.3239	-0.2701	0.1025	0.0168	0.0124	0.0062
3	-0.1192	0.1419	0.0291	0.0275	0.0121	0.0114	0.0090	0.0112
4	-0.0019	0.0	-0.0007	-0.0001	-0.0006	-0.0007	0.0011	0.0002
5	0.0033	-0.0028	-0.0069	0.0003	0.0013	-0.0040	0.0010	-0.0055
SUMS	11692.7010	-6.7299	11763.6833	20.1284	11738.0650	11.9685	11719.5362	5.6404

DAYS 274 THRU 305 JD 2444147.5 TO 2444179.5 DATES OCT 1 THRU NOV 1

A = 16.00000000 B = -18.12500000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5930.1045	-13.3529	6009.2656	18.2521	5989.3939	11.0796	5971.8061	5.0201
1	5756.6134	-7.0837	5766.7195	-2.2577	5773.0970	-0.9702	5774.0817	-0.6810
2	-0.5559	0.6817	0.4088	-0.0990	0.1864	0.0606	0.0791	0.0375
3	-0.0712	0.1473	0.0258	0.0374	0.0163	0.0097	0.0151	0.0024
4	0.0168	0.0047	-0.0021	-0.0014	-0.0008	0.0002	-0.0003	-0.0003
5	-0.0015	0.0015	-0.0061	-0.0033	0.0001	-0.0005	-0.0016	0.0033
SUMS	11686.1061	-19.6014	11776.4115	15.9281	11762.6929	10.1794	11745.9801	4.3820

DAYS 305 THRU 336 JD 2444178.5 TO 2444210.5 DATES NOV 1 THRU DEC 2

A = 16.00000000 B = -20.06250000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5921.2138	-23.4270	6023.9446	13.7476	6015.5914	9.4943	5999.4753	3.8820
1	5754.2706	-2.7937	5768.5125	-2.2590	5774.0125	-0.6303	5774.5236	-0.4753
2	-0.4429	1.4729	0.5430	0.1077	0.2906	0.1142	0.1463	0.0704
3	0.1387	0.0931	0.0337	0.0327	0.0230	0.0023	0.0096	0.0089
4	0.0290	-0.0188	0.0025	-0.0008	-0.0012	-0.0003	0.0010	-0.0019
5	-0.0040	-0.0036	0.0039	0.0059	-0.0044	0.0053	0.0010	-0.0029
SUMS	11675.2052	-24.6771	11793.0402	11.6341	11789.9119	8.9855	11774.1568	3.4812

DAYS 334 THRU 365 JD 2444207.5 TO 2444239.5 DATES NOV 30 THRU DEC 31

A = 16.00000000 B = -21.87500000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5910.4028	-23.3551	6041.4249	10.2471	6042.0466	8.7733	6026.3476	3.2743
1	5754.4013	2.8826	5770.9673	-1.4545	5775.2298	-0.1397	5775.1610	-0.1834
2	0.5122	1.4866	0.8688	0.3487	0.3756	0.1529	0.2008	0.0864
3	0.1402	-0.0911	0.0976	0.0514	0.0122	0.0033	0.0117	-0.0006
4	-0.0237	-0.0193	0.0061	0.0023	-0.0027	-0.0013	-0.0006	0.0025
5	-0.0020	0.0047	-0.0056	-0.0023	-0.0001	-0.0004	-0.0037	0.0026
SUMS	11665.4308	-19.0916	11813.3591	9.1927	11817.6614	8.7881	11801.7168	3.1818

DAYS 1 THRU 6 JD 2443874.5 TO 2443880.5 DATES JAN 1 THRU JAN 6

A = 3.00000000 B = -1.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1548.0058	-2.5928	0.9844	0.2682
1	1042.9091	13.2194	-0.0415	-0.0113
2	2.1212	0.0756	-0.0050	-0.0014
3	-0.7230	-1.1388	0.0117	0.0032
4	-0.1049	0.1501	0.0009	0.0002
5	0.0902	0.0049	-0.0056	-0.0015
SUMS	2592.2984	9.7184	0.9449	0.2574

DAYS 7 THRU 12 JD 2443880.5 TO 2443886.5 DATES JAN 7 THRU JAN 12

A = 3.00000000 B = -3.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1117.1438	17.3166	0.9175	0.2500
1	1044.6182	4.2042	-0.0220	-0.0060
2	-0.1158	-3.7133	0.0091	0.0025
3	0.2786	-0.1986	0.0016	0.0004
4	0.1282	0.1262	-0.0028	-0.0008
5	-0.0391	0.0057	-0.0004	-0.0001
SUMS	2162.0139	17.7408	0.9030	0.2460

DAYS 13 THRU 18 JD 2443886.5 TO 2443892.5 DATES JAN 13 THRU JAN 18

A = 3.00000000 B = -5.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1408.7414	11.3783	0.9007	0.2454
1	1047.9249	-8.9598	0.0042	0.0011
2	1.0241	-2.0782	0.0053	0.0014
3	-0.3318	0.5409	0.0019	0.0005
4	-0.1448	0.0140	0.0024	0.0007
5	0.0147	-0.0073	-0.0004	-0.0001
SUMS	2457.2285	0.8879	0.9141	0.2490

DAYS 19 THRU 24 JD 2443892.5 TO 2443898.5 DATES JAN 19 THRU JAN 24

A = 3.00000000 B = -7.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1344.2192	-10.3556	0.9476	0.2582
1	1044.7060	-10.2966	0.0415	0.0113
2	-3.0541	1.7831	0.0082	0.0022
3	-0.6689	0.9505	0.0033	0.0009
4	0.1860	0.1043	-0.0015	-0.0004
5	0.0862	-0.0109	-0.0041	-0.0011
SUMS	2385.4744	-17.8252	0.9950	0.2711

DAYS 25 THRU 30 JD 2443898.5 TO 2443904.5 DATES JAN 25 THRU JAN 30

A = 3.00000000 B = -9.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1261.5365	-15.8036	1.0238	0.2789
1	1035.9265	7.6262	0.0080	0.0022
2	1.3882	5.0806	-0.0268	-0.0073
3	1.3061	-1.0355	-0.0030	-0.0008
4	-0.3384	-0.4125	0.0039	0.0011
5	-0.1196	0.1010	0.0008	0.0002
SUMS	2299.6993	-4.4438	1.0067	0.2743

DAYS 31 THRU 36 JD 2443904.5 TO 2443910.5 DATES JAN 31 THRU FEB 5

A = 3.00000000 B = -11.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1182.3706	8.5064	0.9619	0.2621
1	1044.0127	11.2949	-0.0475	-0.0129
2	0.7801	-2.4954	0.0016	0.0004
3	-0.4992	-0.6581	0.0083	0.0023
4	0.1003	0.1614	0.0008	0.0002
5	0.0355	-0.0213	-0.0032	-0.0009
SUMS	2226.8000	16.7879	0.9219	0.2512

DAYS 37 THRU 42 JD 2443910.5 TO 2443916.5 DATES FEB 6 THRU FEB 11

A = 3.00000000 B = -13.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1111.7770	17.9173	0.9029	0.2460
1	1045.5656	-2.5671	-0.0098	-0.0027
2	0.8521	-3.5372	0.0093	0.0025
3	0.2464	0.2606	-0.0018	-0.0005
4	-0.0517	0.0942	-0.0009	-0.0002
5	-0.0345	-0.0075	0.0004	0.0001
SUMS	2158.3549	12.1603	0.9001	0.2452

DAYS 43 THRU 48 JD 2443916.5 TO 2443922.5 DATES FEB 12 THRU FEB 17

A = 3.00000000 B = -15.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1406.6401	1.9376	0.9098	0.2479
1	1048.5055	-11.3447	0.0165	0.0045
2	-0.3040	-0.5190	0.0060	0.0016
3	-0.5987	0.6266	0.0025	0.0007
4	-0.0577	0.0253	0.0013	0.0003
5	0.0165	0.0015	-0.0020	-0.0005
SUMS	2454.2017	-9.2727	0.9341	0.2545

DAYS 49 THRU 54 JD 2443922.5 TO 2443928.5 DATES FEB 18 THRU FEB 23

A = 3.00000000 B = -17.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1337.3882	-17.2087	0.9725	0.2650
1	1040.1645	-4.5646	0.0423	0.0115
2	-2.9855	4.3121	0.0020	0.0005
3	0.3760	0.8901	-0.0028	-0.0008
4	0.3474	-0.1312	-0.0021	-0.0006
5	0.0070	-0.0803	-0.0006	-0.0002
SUMS	2375.2976	-16.7826	1.0113	0.2754

DAYS 55 THRU 60 JD 2443928.5 TO 2443934.5 DATES FEB 24 THRU MAR 1

A = 3.00000000 B = -19.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1062.4544	-3.0650	0.5931	0.1616
1	344.4755	6.2264	0.8415	0.2293
2	41.5078	-11.5570	1.5741	0.4288
3	1247.0755	20.9552	-2.7124	-0.7390
4	-31.0502	10.2721	-1.2410	-0.3381
5	-751.5982	-15.9154	1.9258	0.5247
SUMS	1912.8648	6.9163	0.9811	0.2673

DAYS 61 THRU 66 JD 2443934.5 TO 2443940.5 DATES MAR 2 THRU MAR 7

A = 3.00000000 B = -21.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1177.2051	16.1756	0.9357	0.2550
1	1043.7952	5.7394	-0.0401	-0.0109
2	0.5801	-3.8302	0.0123	0.0034
3	0.0633	-0.1546	0.0023	0.0006
4	0.0780	0.1389	-0.0036	-0.0010
5	-0.0182	-0.0155	0.0003	0.0001
SUMS	2221.7035	18.0536	0.9069	0.2472

DAYS 67 THRU 72 JD 2443940.5 TO 2443946.5 DATES MAR 8 THRU MAR 13

A = 3.00000000 B = -23.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1108.1359	12.8772	0.9008	0.2454
1	1047.4738	-8.0607	0.0039	0.0011
2	0.9066	-2.4408	0.0086	0.0023
3	-0.2308	0.4916	-0.0028	-0.0008
4	-0.0891	0.0436	-0.0003	-0.0001
5	0.0071	-0.0046	0.0009	0.0002
SUMS	2156.2035	2.9063	0.9111	0.2481

DAYS 73 THRU 78 JD 2443946.5 TO 2443952.5 DATES MAR 14 THRU MAR 19

A = 3.00000000 B = -25.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1403.6805	-8.4426	0.9315	0.2538
1	1046.1387	-10.6573	0.0231	0.0063
2	-1.8727	1.4703	0.0014	0.0004
3	-0.4857	0.8199	0.0047	0.0013
4	0.0865	0.0322	0.0024	0.0007
5	0.0388	-0.0097	-0.0040	-0.0011
SUMS	2447.5861	-16.7872	0.9591	0.2614

DAYS 79 THRU 84 JD 2443952.5 TO 2443958.5 DATES MAR 20 THRU MAR 25

A = 3.00000000 B = -27.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1327.1558	-17.3730	0.9910	0.2700
1	1038.3873	4.3936	0.0292	0.0079
2	-0.3361	5.0693	-0.0063	-0.0017
3	0.8831	-0.2297	-0.0041	-0.0011
4	-0.0558	-0.3276	-0.0005	-0.0001
5	-0.0929	-0.0072	0.0007	0.0002
SUMS	2365.9414	-8.4746	1.0100	0.2752

DAYS 85 THRU 90 JD 2443958.5 TO 2443964.5 DATES MAR 26 THRU MAR 31

A = 3.00000000 B = -29.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1246.7032	5.0507	0.9939	0.2708
1	1041.6036	13.1095	-0.0333	-0.0091
2	0.6071	-1.7498	-0.0151	-0.0041
3	-0.2115	-1.1942	0.0038	0.0010
4	0.0593	0.1775	0.0020	0.0006
5	0.0353	0.0365	0.0003	0.0001
SUMS	2288.7970	15.4302	0.9516	0.2593

DAYS 91 THRU 96 JD 2443964.5 TO 2443970.5 DATES APR 1 THRU APR 6

A = 3.00000000 B = -31.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1172.2584	18.2707	0.9159	0.2496
1	1044.6033	-1.1496	-0.0261	-0.0071
2	1.3570	-3.7874	0.0127	0.0034
3	0.1447	0.3016	0.0017	0.0005
4	-0.0905	0.0804	-0.0011	-0.0003
5	-0.0195	-0.0174	0.0003	0.0001
SUMS	2218.2534	13.6983	0.9034	0.2462

DAYS 97 THRU 102 JD 2443970.5 TO 2443976.5 DATES APR 7 THRU APR 12

A = 3.00000000 B = -33.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1106.2443	4.0348	0.9122	0.2486
1	1048.2224	-11.2230	0.0188	0.0051
2	-0.2864	-0.9937	0.0032	0.0009
3	-0.5575	0.6121	-0.0064	-0.0017
4	-0.0233	0.0548	0.0038	0.0010
5	0.0172	0.0084	0.0033	0.0009
SUMS	2153.6167	-7.5066	0.9349	0.2548

DAYS 103 THRU 108 JD 2443976.5 TO 2443982.5 DATES APR 13 THRU APR 18

A = 3.00000000 B = -35.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1397.3919	-16.4636	0.9583	0.2611
1	1041.4798	-5.8870	0.0244	0.0067
2	-2.1503	3.9431	-0.0003	-0.0001
3	0.3934	0.7851	-0.0046	-0.0012
4	0.2280	-0.1433	-0.0007	-0.0002
5	-0.0208	-0.0549	0.0032	0.0009
SUMS	2437.3220	-17.8206	0.9803	0.2672

DAYS 109 THRU 114 JD 2443982.5 TO 2443988.5 DATES APR 19 THRU APR 24

A = 3.00000000 B = -37.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1317.1285	-9.8676	0.9943	0.2709
1	1040.8240	11.6388	0.0060	0.0016
2	1.1157	2.7246	-0.0099	-0.0027
3	-0.1276	-1.1347	-0.0015	-0.0004
4	-0.1836	-0.1293	0.0004	0.0001
5	0.0427	0.0437	-0.0003	-0.0001
SUMS	2358.7997	3.2755	0.9890	0.2694

DAYS 115 THRU 120 JD 2443988.5 TO 2443994.5 DATES APR 25 THRU APR 30

A = 3.00000000 B = -39.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1240.9099	14.5104	0.9602	0.2616
1	1042.0430	8.1386	-0.0367	-0.0100
2	0.1060	-3.8404	-0.0018	-0.0005
3	0.3351	-0.5219	0.0048	0.0013
4	0.1287	0.2261	-0.0015	-0.0004
5	-0.0337	0.0033	0.0001	0.0
SUMS	2283.4890	18.5161	0.9251	0.2520

DAYS 121 THRU 126 JD 2443994.5 TO 2444000.5 DATES MAY 1 THRU MAY 6

A = 3.00000000 B = -41.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1168.7128	14.6660	0.9057	0.2468
1	1046.8746	-7.0567	-0.0080	-0.0022
2	1.4862	-2.7199	0.0138	0.0038
3	-0.3211	0.5019	-0.0018	-0.0005
4	-0.1373	0.0053	-0.0020	-0.0005
5	0.0199	-0.0101	0.0029	0.0008
SUMS	2216.6351	5.3865	0.9106	0.2482

DAYS 127 THRU 132 JD 2444000.5 TO 2444006.5 DATES MAY 7 THRU MAY 12

A = 3.00000000 B = -43.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1104.2970	-6.2233	0.9358	0.2550
1	1046.2179	-11.5326	0.0316	0.0086
2	-2.0885	0.8601	-0.0006	-0.0002
3	-0.5722	0.8744	-0.0082	-0.0022
4	0.1256	0.0858	0.0020	0.0005
5	0.0534	-0.0061	0.0042	0.0011
SUMS	2148.0332	-15.9417	0.9648	0.2628

DAYS 133 THRU 138 JD 2444006.5 TO 2444012.5 DATES MAY 13 THRU MAY 18

A = 3.00000000 B = -45.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1387.3359	-18.2551	0.9834	0.2680
1	1038.5031	2.7137	0.0100	0.0027
2	0.2858	5.1314	-0.0060	-0.0016
3	1.0649	-0.2417	0.0038	0.0010
4	-0.1409	-0.3230	-0.0007	-0.0002
5	-0.1198	0.0236	-0.0024	-0.0006
SUMS	2426.9290	-10.9511	0.9881	0.2693

DAYS 139 THRU 144 JD 2444012.5 TO 2444018.5 DATES MAY 19 THRU MAY 24

A = 3.00000000 B = -47.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1309.3607	1.8326	0.9791	0.2668
1	1043.1976	13.3210	-0.0172	-0.0047
2	0.2106	-0.5989	-0.0042	-0.0011
3	-0.5432	-1.1105	0.0061	0.0017
4	0.0719	0.0443	-0.0012	-0.0003
5	0.0581	0.0180	-0.0039	-0.0011
SUMS	2352.3557	13.5065	0.9587	0.2613

DAYS 145 THRU 150 JD 2444018.5 TO 2444024.5 DATES MAY 25 THRU MAY 30

A = 3.00000000 B = -49.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1234.8538	18.6282	0.9298	0.2534
1	1042.9724	0.9202	-0.0275	-0.0075
2	1.0730	-4.2305	0.0022	0.0006
3	0.5891	0.1820	-0.0001	0.0
4	-0.0795	0.1810	0.0011	0.0003
5	-0.0692	-0.0306	0.0027	0.0007
SUMS	2279.3396	15.6503	0.9082	0.2475

DAYS 151 THRU 156 JD 2444024.5 TO 2444030.5 DATES MAY 31 THRU JUNE 5

A = 3.00000000 B = -51.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1167.0372	6.8327	0.9063	0.2469
1	1048.6528	-10.6773	0.0125	0.0034
2	0.3477	-1.3448	0.0130	0.0035
3	-0.6973	0.5133	-0.0068	-0.0018
4	-0.0717	0.0128	-0.0004	-0.0001
5	0.0174	0.0149	0.0055	0.0015
SUMS	2215.2861	-4.6484	0.9301	0.2534

DAYS 157 THRU 162 JD 2444030.5 TO 2444036.5 DATES JUNE 6 THRU JUNE 11

A = 3.00000000 B = -53.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1099.7515	-15.0077	0.9663	0.2633
1	1041.4214	-8.0199	0.0366	0.0100
2	-3.1989	3.4379	-0.0053	-0.0014
3	0.1925	1.1253	-0.0052	-0.0014
4	0.3847	-0.0626	0.0009	0.0002
5	0.0353	-0.0900	0.0013	0.0004
SUMS	2138.5865	-18.6170	0.9946	0.2711

DAYS 163 THRU 168 JD 2444036.5 TO 2444042.5 DATES JUNE 12 THRU JUNE 17

A = 3.00000000 B = -55.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1376.8324	-12.0491	0.9968	0.2716
1	1040.0890	10.7763	-0.0111	-0.0030
2	2.2599	3.1308	-0.0134	-0.0036
3	0.0023	-1.2348	0.0028	0.0008
4	-0.3577	-0.0829	0.0030	0.0008
5	0.0598	0.0735	-0.0002	0.0
SUMS	2418.8857	0.6138	0.9779	0.2666

DAYS 169 THRU 174 JD 2444042.5 TO 2444048.5 DATES JUNE 18 THRU JUNE 23

A = 3.00000000 B = -57.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1302.5805	12.5448	0.9532	0.2597
1	1043.4326	9.6250	-0.0232	-0.0063
2	-0.5269	-3.1069	0.0007	0.0002
3	-0.0522	-0.6924	-0.0076	-0.0021
4	0.2153	0.1279	-0.0005	-0.0001
5	0.0015	0.0201	0.0064	0.0018
SUMS	2345.6508	18.5185	0.9290	0.2532

DAYS 175 THRU 180 JD 2444048.5 TO 2444054.5 DATES JUNE 24 THRU JUNE 29

A = 3.00000000 B = -59.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1229.8293	16.4586	0.9090	0.2477
1	1045.7147	-5.7063	-0.0166	-0.0045
2	1.7831	-3.1649	0.0070	0.0019
3	0.0518	0.5645	0.0051	0.0014
4	-0.1962	0.0475	-0.0005	-0.0001
5	-0.0006	-0.0350	-0.0018	-0.0005
SUMS	2277.1821	8.1644	0.9022	0.2459

DAYS 181 THRU 186 JD 2444054.5 TO 2444060.5 DATES JUNE 30 THRU JULY 5

A = 3.00000000 B = -61.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1165.9464	-3.0685	0.9193	0.2505
1	1048.0994	-11.6137	0.0279	0.0076
2	-1.4846	0.1992	0.0098	0.0027
3	-0.8404	0.6390	0.0015	0.0004
4	0.0149	0.0817	0.0009	0.0002
5	0.0366	0.0219	-0.0027	-0.0007
SUMS	2211.7723	-13.7404	0.9567	0.2607

DAYS 187 THRU 192 JD 2444060.5 TO 2444066.5 DATES JULY 6 THRU JULY 11

A = 3.00000000 B = -63.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1091.3156	-18.7219	0.9981	0.2719
1	1036.8803	-0.1131	0.0305	0.0083
2	-1.5246	5.5930	-0.0135	-0.0037
3	1.4918	0.3751	-0.0028	-0.0008
4	0.1854	-0.4181	-0.0008	-0.0002
5	-0.1694	-0.0680	-0.0002	0.0
SUMS	2128.1791	-13.3530	1.0113	0.2755

DAYS 193 THRU 198 JD 2444066.5 TO 2444072.5 DATES JULY 12 THRU JULY 17

A = 3.00000000 B = -65.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1368.6893	-0.7020	0.9901	0.2698
1	1042.5502	13.6594	-0.0337	-0.0092
2	1.5161	-0.2937	-0.0090	-0.0025
3	-0.6614	-1.1869	0.0086	0.0023
4	-0.0624	0.1336	0.0027	0.0007
5	0.0752	0.0167	-0.0033	-0.0009
SUMS	2412.1070	11.6271	0.9554	0.2602

DAYS 199 THRU 204 JD 2444072.5 TO 2444078.5 DATES JULY 18 THRU JULY 23

A = 3.00000000 B = -67.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1295.6433	18.2406	0.9263	0.2524
1	1043.5022	2.7492	-0.0239	-0.0065
2	0.2937	-4.0865	0.0060	0.0016
3	0.4580	-0.0657	-0.0011	-0.0003
4	0.0772	0.1591	-0.0009	-0.0002
5	-0.0526	0.0035	0.0016	0.0004
SUMS	2339.9218	17.0002	0.9080	0.2474

DAYS 205 THRU 210 JD 2444078.5 TO 2444084.5 DATES JULY 24 THRU JULY 29

A = 3.00000000 B = -69.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1226.9885	9.2503	0.9001	0.2452
1	1048.4669	-9.9501	-0.0007	-0.0002
2	1.0717	-1.6141	0.0073	0.0020
3	-0.4658	0.5844	0.0029	0.0008
4	-0.1229	-0.0060	0.0013	0.0003
5	0.0146	-0.0045	-0.0013	-0.0004
SUMS	2275.9530	-1.7400	0.9096	0.2477

DAYS 211 THRU 216 JD 2444084.5 TO 2444090.5 DATES JULY 30 THRU AUG 4

A = 3.00000000 B = -71.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1163.0840	-12.4818	0.9408	0.2563
1	1044.7007	-9.2892	0.0433	0.0118
2	-3.1082	2.2846	0.0107	0.0029
3	-0.5345	0.9299	-0.0075	-0.0020
4	0.2173	0.0753	-0.0031	-0.0008
5	0.0738	-0.0226	0.0033	0.0009
SUMS	2204.4331	-18.5038	0.9875	0.2691

DAYS 217 THRU 222 JD 2444090.5 TO 2444096.5 DATES AUG 5 THRU AUG 10

A = 3.00000000 B = -73.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1081.2185	-14.7560	1.0203	0.2780
1	1036.8359	9.0962	0.0152	0.0041
2	1.3113	4.6668	-0.0254	-0.0069
3	0.9921	-1.1391	-0.0074	-0.0020
4	-0.3411	-0.3598	0.0036	0.0010
5	-0.0712	0.0996	0.0023	0.0006
SUMS	2119.9455	-2.3923	1.0086	0.2748

DAYS 223 THRU 228 JD 2444096.5 TO 2444102.5 DATES AUG 11 THRU AUG 16

A = 3.00000000 B = -75.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1362.0554	10.5992	0.9692	0.2641
1	1042.9581	10.8299	-0.0424	-0.0116
2	0.4347	-3.0230	-0.0007	-0.0002
3	-0.3950	-0.6722	0.0005	0.0001
4	0.1310	0.1785	0.0012	0.0003
5	0.0210	-0.0109	0.0025	0.0007
SUMS	2405.2952	17.9015	0.9303	0.2534

DAYS 229 THRU 234 JD 2444102.5 TO 2444108.5 DATES AUG 17 THRU AUG 22

A = 3.00000000 B = -77.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1269.4149	18.6175	1.0059	0.2741
1	972.6399	3.5453	0.5921	0.1613
2	294.6108	-16.9420	-1.0431	-0.2842
3	506.2972	-41.0331	-3.2087	-0.8742
4	-470.3541	11.7497	0.9068	0.2471
5	-646.0181	34.1721	2.6461	0.7209
SUMS	1926.5906	10.1095	0.8991	0.2450

DAYS 235 THRU 240 JD 2444108.5 TO 2444114.5 DATES AUG 23 THRU AUG 28

A = 3.00000000 B = -79.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1225.4503	-0.7050	0.9047	0.2465
1	1049.0076	-11.4217	0.0127	0.0035
2	-0.4886	-0.0121	0.0086	0.0024
3	-0.6532	0.6043	0.0023	0.0006
4	-0.0346	0.0194	-0.0004	-0.0001
5	0.0170	0.0105	-0.0004	-0.0001
SUMS	2273.2985	-11.5046	0.9275	0.2528

DAYS 241 THRU 246 JD 2444114.5 TO 2444120.5 DATES AUG 29 THRU SEPT 3

A = 3.00000000 B = -81.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1156.4928	-18.1565	0.9675	0.2636
1	1040.2239	-2.9283	0.0441	0.0120
2	-2.7934	4.5782	0.0048	0.0013
3	0.4959	0.7744	-0.0010	-0.0003
4	0.3062	-0.1643	-0.0039	-0.0011
5	-0.0143	-0.0838	-0.0016	-0.0004
SUMS	2194.7111	-15.9803	1.0099	0.2751

DAYS 247 THRU 252 JD 2444120.5 TO 2444126.5 DATES SEPT 4 THRU SEPT 9

A = 3.00000000 B = -83.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1072.8058	-4.4693	1.0220	0.2785
1	1039.4030	14.1756	-0.0146	-0.0040
2	1.4337	1.1034	-0.0254	-0.0069
3	-0.1291	-1.6523	0.0052	0.0014
4	-0.1851	0.0039	0.0026	0.0007
5	0.0707	0.0947	-0.0016	-0.0004
SUMS	2113.3990	9.2560	0.9882	0.2693

DAYS 253 THRU 258 JD 2444126.5 TO 2444132.5 DATES SEPT 10 THRU SEPT 15

A = 3.00000000 B = -85.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1355.4836	17.5426	0.9422	0.2567
1	1042.7444	4.2506	-0.0424	-0.0116
2	0.8492	-4.2443	0.0109	0.0030
3	0.2725	-0.0158	0.0068	0.0019
4	0.0446	0.1672	-0.0037	-0.0010
5	-0.0387	-0.0250	-0.0035	-0.0010
SUMS	2399.3556	17.6753	0.9103	0.2480

DAYS 259 THRU 264 JD 2444132.5 TO 2444138.5 DATES SEPT 16 THRU SEPT 21

A = 3.00000000 B = -87.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1286.1025	10.9022	0.8996	0.2451
1	1048.0996	-9.2966	-0.0007	-0.0002
2	1.0840	-1.9774	0.0097	0.0026
3	-0.3686	0.5734	-0.0064	-0.0018
4	-0.0825	0.0193	-0.0018	-0.0005
5	0.0177	-0.0077	0.0042	0.0011
SUMS	2334.8527	0.2132	0.9046	0.2463

DAYS 265 THRU 270 JD 2444138.5 TO 2444144.5 DATES SEPT 22 THRU SEPT 27

A = 3.00000000 B = -89.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1222.8277	-10.7852	0.9217	0.2511
1	1046.4875	-9.8189	0.0239	0.0065
2	-2.0036	1.9138	0.0081	0.0022
3	-0.4469	0.7689	-0.0019	-0.0005
4	0.1065	0.0207	-0.0018	-0.0005
5	0.0373	-0.0144	0.0015	0.0004
SUMS	2267.0085	-17.9151	0.9515	0.2592

DAYS 271 THRU 276 JD 2444144.5 TO 2444150.5 DATES SEPT 28 THRU OCT 3

A = 3.00000000 B = -91.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1146.9424	-16.8809	0.9901	0.2698
1	1038.8137	6.0133	0.0381	0.0104
2	-0.3658	4.9584	-0.0060	-0.0016
3	0.7429	-0.3415	-0.0077	-0.0021
4	-0.0867	-0.3237	-0.0003	-0.0001
5	-0.0748	-0.0027	0.0017	0.0005
SUMS	2185.9717	-6.5771	1.0159	0.2769

DAYS 277 THRU 282 JD 2444150.5 TO 2444156.5 DATES OCT 4 THRU OCT 9

A = 3.00000000 B = -93.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1066.1214	7.4996	1.0036	0.2735
1	1040.5036	13.0250	-0.0335	-0.0091
2	0.2088	-2.4656	-0.0186	-0.0051
3	-0.0593	-1.2455	0.0080	0.0022
4	0.1167	0.2182	0.0032	0.0009
5	0.0305	0.0490	-0.0029	-0.0008
SUMS	2106.9217	17.0807	0.9598	0.2616

DAYS 283 THRU 288 JD 2444156.5 TO 2444162.5 DATES OCT 10 THRU OCT 15

A = 3.00000000 B = -95.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1349.6197	18.1222	0.9205	0.2508
1	1044.4099	-3.0943	-0.0307	-0.0084
2	1.9351	-3.7363	0.0111	0.0030
3	0.0769	0.4898	0.0011	0.0003
4	-0.1511	0.0641	-0.0009	-0.0002
5	-0.0040	-0.0256	0.0003	0.0001
SUMS	2395.8865	11.8199	0.9014	0.2456

DAYS 289 THRU 294 JD 2444162.5 TO 2444168.5 DATES OCT 16 THRU OCT 21

A = 3.00000000 B = -97.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1284.5518	1.2729	0.9062	0.2469
1	1048.8733	-11.5568	0.0124	0.0034
2	-0.3780	-0.4170	0.0065	0.0018
3	-0.5990	0.6252	-0.0031	-0.0008
4	0.0056	0.0397	-0.0003	-0.0001
5	0.0180	0.0079	0.0012	0.0003
SUMS	2332.4717	-10.0281	0.9229	0.2515

DAYS 295 THRU 300 JD 2444168.5 TO 2444174.5 DATES OCT 22 THRU OCT 27

A = 3.00000000 B = -99.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1216.7286	-17.7694	0.9468	0.2580
1	1042.0666	-4.3616	0.0258	0.0070
2	-1.9844	4.1199	0.0037	0.0010
3	0.4181	0.6449	-0.0006	-0.0002
4	0.1883	-0.1416	-0.0020	-0.0005
5	-0.0249	-0.0465	0.0008	0.0002
SUMS	2257.3923	-17.5543	0.9745	0.2655

DAYS 301 THRU 306 JD 2444174.5 TO 2444180.5 DATES OCT 28 THRU NOV 2

A = 3.00000000 B = -101.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1137.7381	-8.3005	0.9987	0.2721
1	1040.9294	12.7079	0.0153	0.0042
2	0.5394	2.4579	-0.0133	-0.0036
3	-0.2350	-1.1799	0.0024	0.0007
4	-0.1432	-0.1533	0.0025	0.0007
5	0.0495	0.0305	-0.0043	-0.0012
SUMS	2178.8782	5.5626	1.0013	0.2729

DAYS 307 THRU 312 JD 2444180.5 TO 2444186.5 DATES NOV 3 THRU NOV 8

A = 3.00000000 B = -103.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1059.4352	16.3562	0.9729	0.2651
1	1040.3766	6.9580	-0.0394	-0.0107
2	0.3062	-4.5421	-0.0060	-0.0016
3	0.6660	-0.4121	0.0059	0.0016
4	0.1083	0.2958	0.0006	0.0002
5	-0.0717	0.0003	-0.0009	-0.0003
SUMS	2100.8206	18.6561	0.9331	0.2543

DAYS 313 THRU 318 JD 2444186.5 TO 2444192.5 DATES NOV 9 THRU NOV 14

A = 3.00000000 B = -105.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1346.1152	12.9478	0.9067	0.2470
1	1047.3897	-8.6025	-0.0148	-0.0040
2	1.7505	-2.2910	0.0136	0.0037
3	-0.5037	0.5893	0.0044	0.0012
4	-0.1248	-0.0212	-0.0008	-0.0002
5	0.0353	-0.0064	-0.0033	-0.0009
SUMS	2394.6622	2.6160	0.9058	0.2468

DAYS 319 THRU 324 JD 2444192.5 TO 2444198.5 DATES NOV 15 THRU NOV 20

A = 3.00000000 B = -107.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1282.8068	-8.9263	0.9248	0.2520
1	1046.5872	-10.8784	0.0261	0.0071
2	-2.1522	1.4392	0.0068	0.0018
3	-0.4860	0.8469	-0.0039	-0.0011
4	0.1547	0.0585	-0.0029	-0.0008
5	0.0464	-0.0146	0.0002	0.0
SUMS	2326.9569	-17.4747	0.9511	0.2590

DAYS 325 THRU 330 JD 2444198.5 TO 2444204.5 DATES NOV 21 THRU NOV 26

A = 3.00000000 B = -109.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1207.1676	-18.1348	0.9728	0.2651
1	1039.6679	4.2607	0.0182	0.0050
2	0.3769	4.8822	-0.0029	-0.0008
3	0.8204	-0.3335	-0.0005	-0.0001
4	-0.1838	-0.2741	-0.0006	-0.0002
5	-0.0831	0.0221	-0.0003	-0.0001
SUMS	2247.7659	-9.5774	0.9867	0.2689

DAYS 331 THRU 336 JD 2444204.5 TO 2444210.5 DATES NOV 27 THRU DEC 2

A = 3.00000000 B = -111.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1130.1362	3.8773	0.9895	0.2696
1	1042.4129	13.6710	-0.0053	-0.0014
2	-0.5150	-1.0038	-0.0127	-0.0035
3	-0.4884	-1.2304	-0.0041	-0.0011
4	0.1347	0.0244	0.0030	0.0008
5	0.0649	0.0342	0.0025	0.0007
SUMS	2171.7453	15.3727	0.9729	0.2651

DAYS 337 THRU 342 JD 2444210.5 TO 2444216.5 DATES DEC 3 THRU DEC 8

A = 3.00000000 B = -113.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1412.6776	19.0557	0.9417	0.2566
1	1041.9256	-0.9833	-0.0335	-0.0091
2	1.7966	-4.4746	0.0016	0.0004
3	0.6809	0.4400	0.0048	0.0013
4	-0.1894	0.1944	-0.0004	-0.0001
5	-0.0662	-0.0539	-0.0014	-0.0004
SUMS	2456.8251	14.1783	0.9128	0.2487

DAYS 343 THRU 348 JD 2444216.5 TO 2444222.5 DATES DEC 9 THRU DEC 14

A = 3.00000000 B = -115.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1345.0065	4.1540	0.9039	0.2463
1	1049.2053	-11.3563	0.0042	0.0011
2	0.2885	-0.7887	0.0154	0.0042
3	-0.7929	0.5264	0.0026	0.0007
4	-0.0356	0.0044	-0.0022	-0.0006
5	0.0200	0.0220	-0.0026	-0.0007
SUMS	2393.6918	-7.4382	0.9213	0.2510

DAYS 349 THRU 354 JD 2444222.5 TO 2444228.5 DATES DEC 15 THRU DEC 20

A = 3.00000000 B = -117.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1278.4222	-16.7705	0.9550	0.2602
1	1041.7858	-6.4965	0.0356	0.0097
2	-2.9327	3.8273	-0.0041	-0.0011
3	0.3674	0.9728	-0.0068	-0.0019
4	0.3569	-0.1023	0.0017	0.0005
5	0.0002	-0.0844	0.0017	0.0005
SUMS	2317.9998	-18.6536	0.9831	0.2679

DAYS 355 THRU 360 JD 2444228.5 TO 2444234.5 DATES DEC 21 THRU DEC 26

A = 3.00000000 B = -119.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1197.4381	-10.7180	0.9910	0.2700
1	1041.0567	11.7553	-0.0038	-0.0010
2	1.7967	2.7477	-0.0093	-0.0025
3	-0.1868	-1.2002	0.0081	0.0022
4	-0.3034	-0.0705	0.0009	0.0002
5	0.0631	0.0575	-0.0048	-0.0013
SUMS	2239.8644	2.5718	0.9821	0.2676

DAYS 360 THRU 365 JD 2444233.5 TO 2444239.5 DATES DEC 26 THRU DEC 31

A = 3.00000000 B = -121.00000000

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1135.1978	10.9959	0.9709	0.2645
1	1042.5866	11.1813	-0.0171	-0.0047
2	-0.8532	-2.8434	-0.0013	-0.0004
3	-0.2049	-0.9251	-0.0044	-0.0012
4	0.2430	0.1132	-0.0020	-0.0005
5	0.0377	0.0315	0.0032	0.0009
SUMS	2177.0070	18.5534	0.9493	0.2586

Section D: ASTRONOMICAL TABLES

With two exceptions the series in this section provide data referred to the true equator and equinox of date. The exceptions are

1. the Moon's geocentric, rectangular coordinates (X, Y, Z), which are referred to the mean equator and equinox of 1950.0;
2. the right ascension and declination of Pluto, which are astrometric (*i.e.*, free of the effect of stellar aberration, except for the elliptic part) and are referred to the mean equator and equinox of 1950.0.

The unit of distance for the Sun and planets is the Astronomical Unit; the unit of distance for the Moon is the Earth's radius.

CHEBYSHEV APPROXIMATION OF SIDEREAL TIME FOR YEAR 1979

DAYS 1 THRU 95 JD 2443874.5 TO 2443969.5 DATES JAN 1 THRU APR 5

A = 47.50000000 B = -1.02105263

TERM	APP S T H	EQ OF EQ S	NUT LON "	NUT OBL "
0	19.58263826	-0.3485	-5.6980	-18.0263
1	3.12119355	-0.0830	-1.3575	0.6524
2	-0.00001002	-0.0361	-0.5898	-0.1388
3	0.00000144	0.0052	0.0849	-0.0965
4	0.00000171	0.0062	0.1006	0.0047
5	-0.00000014	-0.0005	-0.0082	-0.0050
6	0.00000066	0.0024	0.0391	-0.0072
7	0.00000005	0.0002	0.0028	0.0049
8	0.00000026	0.0009	0.0153	-0.0073
9	-0.00000005	-0.0002	-0.0028	0.0203
10	0.00000069	0.0025	0.0409	-0.0048
11	0.00000051	0.0018	0.0297	0.0236
12	-0.00000100	-0.0036	-0.0589	0.0069
13	0.0	0.0	0.0	0.0030
14	-0.00000084	-0.0030	-0.0494	0.0066
15	-0.00000038	-0.0014	-0.0223	-0.0253
16	0.00000049	0.0018	0.0290	-0.0066
17	-0.00000003	-0.0001	-0.0020	-0.0073
18	0.00000088	0.0032	0.0521	-0.0083
19	0.00000063	0.0023	0.0368	0.0298
20	-0.00000115	-0.0042	-0.0679	0.0165
21	-0.00000059	-0.0021	-0.0346	-0.0245
22	0.00000076	0.0027	0.0445	-0.0090
23	0.00000018	0.0006	0.0104	0.0139
24	-0.00000040	-0.0014	-0.0235	0.0009
25	0.0	0.0	0.0002	-0.0064
26	0.00000013	0.0005	0.0077	-0.0003
27	0.00000005	0.0002	0.0032	0.0006
28	0.00000006	0.0002	0.0037	0.0024
29	-0.00000012	-0.0004	-0.0070	0.0025
30	-0.00000012	-0.0004	-0.0071	-0.0033
31	0.00000013	0.0005	0.0075	-0.0024
32	0.00000008	0.0003	0.0046	0.0029
33	-0.00000010	-0.0004	-0.0059	0.0012
34	-0.00000003	-0.0001	-0.0019	-0.0019
35	0.00000005	0.0002	0.0030	-0.0005
SUMS	22.70382560	-0.4537	-7.4208	-17.5886

CHEBYSHEV APPROXIMATION OF SIDEREAL TIME FOR YEAR 1979

DAYS 91 THRU 185 JD 2443964.5 TO 2444059.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.91578947

TERM	APP S T H	EQ OF EQ S	NUT LON ''	NUT OBL ''
0	31.41032190	-0.6530	-10.6765	-18.0358
1	3.12121210	-0.0162	-0.2656	-0.4407
2	0.00000949	0.0342	0.5587	0.1199
3	-0.00000188	-0.0068	-0.1105	0.0906
4	-0.00000129	-0.0047	-0.0762	-0.0099
5	-0.00000046	-0.0016	-0.0268	0.0099
6	-0.00000101	-0.0036	-0.0593	-0.0029
7	-0.00000001	0.0	-0.0004	-0.0016
8	-0.00000094	-0.0034	-0.0555	-0.0029
9	0.00000058	0.0021	0.0341	-0.0191
10	-0.00000015	-0.0006	-0.0091	-0.0005
11	-0.00000021	-0.0007	-0.0121	-0.0223
12	0.00000068	0.0025	0.0401	0.0020
13	0.00000015	0.0005	0.0088	-0.0026
14	0.00000085	0.0031	0.0503	0.0028
15	-0.00000015	-0.0005	-0.0087	0.0252
16	-0.00000058	-0.0021	-0.0344	-0.0015
17	-0.00000006	-0.0002	-0.0036	0.0041
18	-0.00000090	-0.0033	-0.0532	-0.0030
19	0.00000020	0.0007	0.0116	-0.0334
20	0.00000146	0.0052	0.0858	0.0043
21	-0.00000016	-0.0006	-0.0093	0.0312
22	-0.00000092	-0.0033	-0.0542	-0.0026
23	0.00000007	0.0002	0.0039	-0.0137
24	0.00000027	0.0010	0.0160	0.0009
25	-0.00000002	-0.0001	-0.0010	0.0025
26	-0.00000004	-0.0001	-0.0022	-0.0002
27	0.00000001	0.0	0.0007	-0.0011
28	0.00000008	0.0003	0.0047	0.0002
29	-0.00000001	-0.0001	-0.0008	0.0029
30	-0.00000014	-0.0005	-0.0080	-0.0003
31	0.00000001	0.0	0.0006	-0.0033
32	0.00000012	0.0004	0.0070	0.0002
33	0.0	0.0	-0.0003	0.0023
34	-0.00000006	-0.0002	-0.0036	-0.0001
35	0.0	0.0	0.0001	-0.0009
SUMS	34.53153898	-0.6514	-10.6489	-18.2994

CHEBYSHEV APPROXIMATION OF SIDEREAL TIME FOR YEAR 1979

DAYS 182 THRU 276   JD 2444055.5 TO 2444150.5   DATES JULY 1 THRU OCT 3

A = 47.50000000   B = -4.83157895

TERM	APP S T H	EQ OF EQ S	NUT LON ''	NUT OBL ''
0	43.36949367	-0.7110	-11.6246	-17.1532
1	3.12119588	-0.0746	-1.2203	0.7350
2	-0.00001034	-0.0372	-0.6083	-0.0705
3	0.00000156	0.0056	0.0917	-0.0837
4	0.00000087	0.0031	0.0511	0.0215
5	0.00000043	0.0015	0.0250	-0.0008
6	0.00000085	0.0030	0.0498	0.0213
7	-0.00000005	-0.0002	-0.0030	0.0047
8	0.00000105	0.0038	0.0617	0.0198
9	-0.00000087	-0.0031	-0.0513	0.0132
10	-0.00000055	-0.0020	-0.0325	0.0054
11	-0.00000081	-0.0029	-0.0477	0.0121
12	-0.00000018	-0.0007	-0.0108	-0.0180
13	-0.00000008	-0.0003	-0.0046	0.0024
14	-0.00000061	-0.0022	-0.0360	-0.0200
15	0.00000096	0.0035	0.0566	-0.0138
16	0.00000019	0.0007	0.0114	0.0132
17	0.00000017	0.0006	0.0101	-0.0059
18	0.00000054	0.0019	0.0316	0.0213
19	-0.00000120	-0.0043	-0.0707	0.0139
20	-0.00000051	-0.0018	-0.0298	-0.0316
21	0.00000105	0.0038	0.0620	-0.0100
22	0.00000037	0.0013	0.0216	0.0192
23	-0.00000049	-0.0018	-0.0289	0.0083
24	-0.00000029	-0.0011	-0.0173	-0.0074
25	0.00000018	0.0006	0.0103	-0.0052
26	0.00000010	0.0004	0.0058	0.0026
27	-0.00000006	-0.0002	-0.0035	-0.0005
28	0.00000011	0.0004	0.0062	-0.0007
29	0.00000001	0.0	0.0008	0.0040
30	-0.00000017	-0.0006	-0.0102	0.0003
31	-0.00000002	-0.0001	-0.0011	-0.0041
32	0.00000014	0.0005	0.0082	-0.0008
33	0.00000003	0.0001	0.0020	0.0027
34	-0.00000008	-0.0003	-0.0047	0.0008
35	-0.00000002	-0.0001	-0.0012	-0.0013
SUMS	46.49068183	-0.8137	-13.3006	-16.5058

CHEBYSHEV APPROXIMATION OF SIDEREAL TIME FOR YEAR 1979

DAYS 274 THRU 368 JD 2444147.5 TO 2444242.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.76842105

TERM	APP S T H	EQ OF EQ S	NUT LON "	NUT OBL "
0	7.46001951	-1.0051	-16.4321	-16.8710
1	3.12121451	-0.0076	-0.1241	-0.4429
2	0.00001248	0.0449	0.7346	0.0965
3	-0.00000115	-0.0041	-0.0676	0.0763
4	-0.00000006	-0.0002	-0.0033	-0.0173
5	0.00000024	0.0009	0.0140	-0.0081
6	0.00000058	0.0021	0.0340	-0.0131
7	0.00000019	0.0007	0.0114	0.0063
8	0.00000053	0.0019	0.0311	-0.0110
9	-0.00000004	-0.0002	-0.0025	0.0183
10	0.00000048	0.0017	0.0285	-0.0041
11	0.00000082	0.0029	0.0481	0.0243
12	-0.00000094	-0.0034	-0.0553	0.0108
13	-0.00000004	-0.0001	-0.0021	0.0018
14	-0.00000089	-0.0032	-0.0523	0.0123
15	-0.00000054	-0.0019	-0.0317	-0.0256
16	0.00000044	0.0016	0.0262	-0.0074
17	-0.00000009	-0.0003	-0.0051	-0.0085
18	0.00000097	0.0035	0.0570	-0.0121
19	0.00000068	0.0024	0.0397	0.0290
20	-0.00000111	-0.0040	-0.0654	0.0188
21	-0.00000066	-0.0024	-0.0387	-0.0223
22	0.00000071	0.0026	0.0419	-0.0126
23	0.00000031	0.0011	0.0182	0.0135
24	-0.00000041	-0.0015	-0.0243	0.0042
25	-0.00000007	-0.0002	-0.0040	-0.0070
26	0.00000015	0.0005	0.0090	-0.0008
27	0.00000003	0.0001	0.0017	0.0010
28	0.00000005	0.0002	0.0028	0.0007
29	-0.00000003	-0.0001	-0.0019	0.0026
30	-0.00000013	-0.0005	-0.0075	-0.0005
31	0.00000002	0.0001	0.0010	-0.0032
32	0.00000011	0.0004	0.0067	0.0002
33	-0.00000001	0.0	-0.0006	0.0022
34	-0.00000007	-0.0002	-0.0038	-0.0003
35	0.00000001	0.0001	0.0008	-0.0011
SUMS	10.58124658	-0.9673	-15.8156	-17.1501

DAYS 1 THRU 95 JD 2443874.5 TO 2443969.5 DATES JAN 1 THRU APR 5

A = 47.50000000 B = -1.02105263

TERM	R A H	DEC DEG	DISTANCE AU	S D '	EPHEM TR H
0	43.8577461	-20.549753	1.98018037	32.36140	24.2754532
1	3.1064843	15.086874	0.00892328	-0.14557	-0.0182740
2	-0.0928485	1.815646	0.00189982	-0.03044	-0.0921423
3	0.0119072	-0.488865	-0.00028165	0.00489	0.0122811
4	0.0043867	-0.001138	-0.00002204	0.00035	0.0043041
5	-0.0007466	0.005281	-0.00001085	0.00015	-0.0007555
6	-0.0000155	-0.001176	-0.00000056	0.00002	-0.0000117
7	0.0000451	0.000048	-0.00001157	0.00019	0.0000394
8	-0.0000746	-0.000243	-0.00000747	0.00012	-0.0000775
9	-0.0000283	-0.000107	0.00001672	-0.00027	-0.0000212
10	0.0000482	0.000166	0.00000559	-0.00009	0.0000497
11	0.0000132	0.000067	-0.00000714	0.00013	0.0000092
12	-0.0000165	-0.000051	-0.00000168	0.00003	-0.0000158
13	-0.0000017	-0.000020	0.00000193	-0.00003	-0.0000003
14	0.0000027	0.000006	0.00000002	-0.00002	0.0000039
15	-0.0000006	0.000004	-0.00000038	0.0	-0.0000006
16	0.0000003	0.0	-0.00000014	-0.00001	0.0000001
17	-0.0000012	-0.000008	-0.00000018	0.00002	-0.0000014
18	-0.0000002	0.000005	0.00000036	0.00001	-0.0000009
19	0.0000022	0.000005	0.00000028	-0.00002	0.0000018
20	-0.0000002	-0.000005	-0.00000033	0.0	0.0000005
21	-0.0000020	-0.000006	-0.00000017	0.00001	-0.0000012
SUMS	46.8869001	-4.133270	1.99068421	32.19087	24.1808406

DAYS 91 THRU 185 JD 2443964.5 TO 2444059.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.91578947

TERM	R A H	DEC DEG	DISTANCE AU	S D '	EPHEM TR H
0	7.4304526	32.948801	2.01943950	31.73224	24.0199017
1	3.1286272	9.607632	0.00902054	-0.14199	0.0097870
2	0.0658562	-2.967648	-0.00180345	0.02891	0.0654362
3	-0.0064655	-0.295429	-0.00025030	0.00368	-0.0068578
4	-0.0049072	0.036151	0.00002722	-0.00045	-0.0048968
5	0.0000811	0.005978	-0.00001323	0.00023	0.0000932
6	0.0001480	0.000186	-0.00000036	0.0	0.0001514
7	0.0000178	0.0	-0.00001176	0.00020	0.0000124
8	-0.0000797	-0.000213	-0.00000212	0.00001	-0.0000791
9	-0.0000081	-0.000069	0.00001817	-0.00029	-0.0000008
10	0.0000540	0.000140	0.00000157	-0.00002	0.0000541
11	0.0000045	-0.000009	-0.00000840	0.00012	0.0000012
12	-0.0000162	-0.000052	-0.00000053	0.0	-0.0000172
13	-0.0000012	0.000008	0.00000178	-0.00003	-0.0000004
14	0.0000032	0.000011	0.00000006	0.0	0.0000022
15	0.0	0.000004	-0.00000010	-0.00001	0.0000001
16	-0.0000012	-0.000002	-0.00000001	-0.00001	-0.0000004
17	-0.0000003	0.000001	0.00000021	0.00001	-0.0000002
18	-0.0000001	-0.000002	0.00000005	0.00001	0.0000010
19	0.0000003	-0.000007	-0.00000032	0.00001	0.0000001
20	0.0000003	0.000002	-0.00000006	0.0	-0.0000014
21	-0.0000004	0.000004	0.00000025	-0.00001	-0.0000002
SUMS	10.6137653	39.335487	2.02641871	31.62261	24.0835863

CHEBYSHEV APPROXIMATION OF SOLAR COORDINATES FOR YEAR 1979

DAYS 182 THRU 276 JD 2444055.5 TO 2444150.5 DATES JULY 1 THRU OCT 3

A = 47.50000000 B = -4.83157895

TERM	R A	DEC	DISTANCE	S D	EPHEM TR
	H	DEG	AU	'	H
0	19.3692472	23.068389	2.02090351	31.70909	23.9976259
1	2.9897698	-13.969749	-0.00834605	0.13122	-0.1338289
2	-0.0651569	-1.979982	-0.00193638	0.03091	-0.0644887
3	0.0107568	0.377207	0.00022102	-0.00322	0.0110699
4	0.0038452	0.010929	0.00002169	-0.00033	0.0037913
5	-0.0004805	-0.002649	-0.00001524	0.00022	-0.0004904
6	-0.0000326	0.000801	0.00000086	-0.00003	-0.0000302
7	-0.0000012	0.000157	-0.00001097	0.00015	-0.0000063
8	-0.0000699	0.000187	0.00000805	-0.00012	-0.0000675
9	0.0000302	-0.000093	0.00001653	-0.00027	0.0000373
10	0.0000452	-0.000156	-0.00000609	0.00008	0.0000429
11	-0.0000162	0.000027	-0.00000715	0.00009	-0.0000181
12	-0.0000146	0.000060	0.00000185	-0.00004	-0.0000134
13	0.0000030	0.000011	0.00000201	-0.00003	0.0000031
14	0.0000035	-0.000018	-0.00000011	0.00001	0.0000036
15	0.0000010	-0.000006	-0.00000041	0.00001	-0.0000002
16	0.0	-0.000001	0.00000013	-0.00001	-0.0000001
17	0.0000011	-0.000007	-0.00000023	0.0	0.0000007
18	-0.0000005	0.000005	-0.00000036	-0.00001	-0.0000014
19	-0.0000026	0.000012	0.00000033	0.0	-0.0000011
20	0.0000005	-0.000008	0.00000032	0.0	0.0000010
21	0.0000020	-0.000009	-0.00000019	0.0	0.0000006
SUMS	22.3079305	7.505107	2.01085312	31.86772	23.8136300

DAYS 274 THRU 368 JD 2444147.5 TO 2444242.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.76842105

TERM	R A	DEC	DISTANCE	S D	EPHEM TR
	H	DEG	AU	'	H
0	31.1750839	-31.679976	1.98100625	32.34800	23.7172770
1	3.2497390	-10.383545	-0.00928620	0.15138	0.1322761
2	0.1025289	3.029362	0.00178759	-0.02852	0.1020058
3	-0.0080610	0.414252	0.00028487	-0.00493	-0.0085757
4	-0.0066181	-0.035353	-0.00003673	0.00061	-0.0066427
5	-0.0002351	-0.010753	-0.00000877	0.00014	-0.0002131
6	0.0002143	-0.000828	0.00000223	-0.00001	0.0002204
7	-0.0000104	0.000362	-0.00000482	0.00006	-0.0000119
8	-0.0000307	0.000255	0.00001811	-0.00031	-0.0000236
9	0.0000661	-0.000187	0.00000697	-0.00011	0.0000685
10	0.0000224	-0.000076	-0.00001196	0.00019	0.0000166
11	-0.0000271	0.000097	-0.00000315	0.00006	-0.0000291
12	-0.0000084	0.000018	0.00000378	-0.00006	-0.0000063
13	0.0000072	-0.000040	0.00000073	0.0	0.0000077
14	0.0000003	-0.000002	-0.00000105	0.00002	0.0000004
15	-0.0000028	0.000013	0.0	0.0	-0.0000017
16	0.0000003	-0.000002	0.00000010	-0.00001	0.0
17	-0.0000006	0.000007	0.00000005	0.0	-0.0000003
18	0.0000016	0.000004	0.00000030	-0.00001	0.0000009
19	0.0000022	-0.000015	-0.00000012	0.00001	0.0000012
20	-0.0000016	0.0	-0.00000031	0.0	-0.0000007
21	-0.0000018	0.000007	0.00000006	-0.00002	-0.0000010
SUMS	34.5126686	-38.666400	1.97375793	32.46649	23.9363685

DAYS 1 THRU 32 JD 2443874.5 TO 2443906.5 DATES JAN 1 THRU FEB 1

A = 16.00000000 B = -1.06250000

	R A	CEC	H P	X	Y	Z
TERM	H	DEG	'	E RAD	E RAD	E RAD
0	69.57903896	-3.4606433	116.4494109	39.2686947	-6.3891394	-2.8277223
1	13.95134072	-2.0364143	0.5446774	-3.6704016	-6.5359125	-2.1948767
2	0.31433657	-6.0066344	2.7219761	49.8515524	-16.4868565	-6.4734233
3	0.29282920	14.1574017	-1.7484791	17.4584513	44.2739743	14.4095202
4	-0.07496529	3.3978201	-1.3103162	-25.7597475	9.2632820	3.5454142
5	-0.11718436	-2.4785799	-0.1534466	-4.5950584	-9.1806348	-2.9528508
6	-0.07750610	-0.6750195	0.1030224	2.2902437	-1.6409277	-0.5829063
7	0.03591643	-0.2788834	0.2386781	0.5799255	0.0428174	0.0010785
8	0.03332330	-0.0430359	0.0458324	0.2819688	0.1204932	0.0342219
9	-0.00000017	0.1095859	-0.0271058	0.0230763	0.1574914	0.0518220
10	-0.00319482	0.1010281	-0.0184265	-0.0530489	0.0467473	0.0165518
11	-0.00277586	0.0077197	-0.0095573	-0.0355938	-0.0035205	-0.0004517
12	-0.00208299	-0.0270568	0.0002543	-0.0083827	-0.0162831	-0.0052400
13	0.00007924	-0.0113420	0.0026179	0.0053244	-0.0066384	-0.0023038
14	0.00104702	-0.0018158	0.0015587	0.0035524	0.0002727	0.0000199
15	0.00041462	0.0017522	0.0002490	0.0009694	0.0011437	0.0003588
16	-0.00010920	0.0026436	-0.0003114	-0.0001331	0.0007430	0.0002485
17	-0.00013561	0.0010025	-0.0002216	-0.0003679	0.0001662	0.0000628
18	-0.00007613	-0.0004367	-0.0000607	-0.0001743	-0.0000934	-0.0000273
19	-0.00001611	-0.0005267	0.0000205	-0.0000126	-0.0000936	-0.0000308
20	0.00002875	-0.0001525	0.0000306	0.0000367	-0.0000317	-0.0000113
21	0.00002517	0.0000406	0.0000131	0.0000239	0.0000054	0.0000014
22	0.00000245	0.0000796	0.0	0.0000049	0.0000106	0.0000034
23	-0.00000636	0.0000481	-0.0000039	-0.0000030	0.0000051	0.0000017
24	-0.00000432	-0.0000004	-0.0000022	-0.0000033	0.0000001	0.0000002
25	-0.00000118	-0.0000183	-0.0000002	-0.0000010	-0.0000013	-0.0000004
26	0.00000077	-0.0000104	0.0000003	0.0000003	-0.0000007	-0.0000002
27	0.00000117	-0.0000002	0.0000003	0.0000002	-0.0000001	0.0
28	0.00000042	0.0000030	0.0000001	0.0000002	0.0000001	0.0
29	-0.00000016	0.0000021	0.0	0.0000001	0.0000002	0.0
30	-0.00000025	0.0000004	0.0	0.0	0.0000001	0.0000001
31	-0.00000010	-0.0000004	-0.0000001	0.0	0.0000001	0.0
32	0.00000004	-0.0000008	0.0	0.0	0.0	0.0
33	0.00000003	-0.0000001	0.0	0.0	-0.0000001	0.0
34	0.00000003	0.0	0.0000001	0.0000001	0.0	0.0
35	0.00000002	0.0	0.0	0.0	0.0	0.0000001
SUMS	83.93032590	2.7585558	116.8404106	75.6408972	13.6470191	3.0194606

DAYS 32 THRU 63 JD 2443905.5 TO 2443937.5 DATES FEB 1 THRU MAR 4

A = 16.00000000 B = -3.00000000

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	"	E RAD	E RAD	E RAD
0	28.08662826	8.4510801	114.7277738	33.6567235	30.0026519	9.2369240
1	13.98990886	-2.3069660	0.7457748	2.6544885	-6.9868468	-2.4199789
2	0.39584558	7.2668969	0.8768237	45.9678298	24.6394841	7.1628248
3	0.10411406	13.3351541	-2.8156104	-23.1826113	40.8794184	14.0203725
4	-0.19160254	-3.3033711	-0.6561151	-24.7695165	-12.1775813	-3.5046592
5	-0.09339354	-3.3374477	0.2490881	4.0658040	-10.0421041	-3.3996825
6	0.05127150	-0.3044084	0.3404139	3.6977768	0.4382085	0.0662389
7	0.05267822	0.3115857	0.1798009	0.4974230	1.0236294	0.3264663
8	-0.00865142	0.3164381	-0.0620264	-0.2189110	0.4092018	0.1399042
9	-0.01549363	0.0820621	-0.0652120	-0.2189963	0.0172731	0.0104496
10	-0.00348812	-0.0706842	-0.0147540	-0.0609185	-0.0740113	-0.0231163
11	0.00225991	-0.0587218	0.0087307	0.0145047	-0.0442238	-0.0149211
12	0.00281590	0.0000541	0.0088188	0.0253015	-0.0050246	-0.0022073
13	0.00048922	0.0165074	0.0021574	0.0080304	0.0098860	0.0030921
14	-0.00093614	0.0069594	-0.0012581	-0.0027546	0.0053642	0.0018302
15	-0.00051927	-0.0016495	-0.0013691	-0.0030068	0.0001200	0.0001047
16	0.00011800	-0.0031170	-0.0003418	-0.0007905	-0.0011828	-0.0003727
17	0.00021716	-0.0008268	0.0002267	0.0003395	-0.0006125	-0.0002096
18	0.00006129	0.0006994	0.0002115	0.0003659	-0.0000117	-0.0000121
19	-0.00005024	0.0005494	0.0000462	0.0001001	0.0001504	0.0000475
20	-0.00004803	0.0000008	-0.0000366	-0.0000453	0.0000805	0.0000277
21	-0.00000195	-0.0001780	-0.0000330	-0.0000502	0.0000003	0.0000012
22	0.00001729	-0.0000778	-0.0000068	-0.0000125	-0.0000217	-0.0000068
23	0.00000811	0.0000277	0.0000062	0.0000073	-0.0000105	-0.0000036
24	-0.00000272	0.0000392	0.0000052	0.0000067	0.0000008	0.0
25	-0.00000423	0.0000068	0.0000010	0.0000014	0.0000029	0.0000009
26	-0.00000097	-0.0000110	-0.0000011	-0.0000010	0.0000012	0.0000005
27	0.00000119	-0.0000071	-0.0000009	-0.0000008	0.0	0.0
28	0.00000089	0.0000010	-0.0000001	-0.0000002	-0.0000004	-0.0000001
29	-0.00000004	0.0000028	0.0000002	0.0000001	-0.0000001	0.0
30	-0.00000038	0.0000009	0.0000001	0.0000001	0.0000001	0.0000001
31	-0.00000013	-0.0000007	0.0	0.0	0.0000001	0.0
32	0.00000007	-0.0000005	-0.0000002	0.0	0.0	0.0000001
33	0.00000010	0.0	-0.0000002	0.0	-0.0000001	0.0
34	0.00000002	0.0000004	-0.0000002	0.0	0.0000001	0.0
35	-0.00000004	0.0000003	0.0	-0.0000001	0.0	0.0
SUMS	42.37224224	20.4005990	113.5231[illegible]32	42.1310877	68.0938421	21.6031151

DAYS 60 THRU 91 JD 2443933.5 TO 2443965.5 DATES MAR 1 THRU APR 1

A = 16.00000000 B = -4.75000C00

	R A	CEC	H P	X	Y	Z
TERM	H	DEG	"	E RAD	E RAD	E RAD
0	29.23804087	9.8700092	114.7993786	29.2629514	33.8163932	10.5465352
1	13.98446988	-2.1341046	0.5331283	4.1907234	-6.6184194	-2.2592237
2	0.34573242	9.3093377	0.9852712	41.2577693	30.8538822	9.3123347
3	0.10755174	12.2347003	-2.6236804	-29.6278532	37.1839266	12.9386355
4	-0.18048460	-4.4472720	-0.4372378	-22.3607402	-15.663021C	-4.6843812
5	-0.05034667	-3.1328361	0.1880429	5.7812058	-9.2456C04	-3.1836216
6	0.05927321	-0.0620080	0.1295685	3.5186864	1.C899188	0.2810765
7	0.02672312	0.3925725	0.1727318	0.2161811	1.C789486	0.3516513
8	-0.01631433	0.2545621	-0.0033927	-0.3111349	0.2950767	0.1046039
9	-0.01047823	0.0013473	-0.0435925	-0.1671527	-0.05C1939	-0.0128553
1C	0.00042394	-0.0601907	-0.0174706	-0.0166900	-0.0549549	-0.0178050
11	0.00308578	-0.0235267	0.0016555	0.0095319	-0.0213793	-0.0072895
12	0.00146298	0.0066781	0.0053452	0.0136C62	-0.C041946	-0.0016882
13	-0.00056707	0.0084921	0.0018339	0.0056612	0.C052166	C.0016010
14	-0.00071031	0.0011151	-0.0000812	-0.0011595	0.C034774	0.0011753
15	-0.00003485	-0.0019728	-0.0005222	-C.0017983	C.C0C321C	0.0001455
16	0.00021166	-0.0009872	-0.0003125	-0.C005598	-0.00C6458	-0.0002008
17	0.00008662	0.0003199	-0.00C0197	0.0001559	-0.C0C359C	-0.0001220
18	-0.00003655	0.0003896	0.0000761	0.0001829	-0.C000214	-0.0000114
19	-0.00004487	0.0000093	0.0000475	0.0000552	0.C0C0608	0.0000188
20	-0.00000411	-0.0001183	0.C0C0032	-0.0000100	0.C0C0372	0.0000127
21	0.00001451	-0.0000415	-0.0000111	-0.0000196	0.0000C61	0.0000024
22	0.00000672	0.0000260	-0.0000062	-0.0000C79	-0.00C0C65	-0.0000020
23	-C.00000258	0.0000238	-0.0C00004	0.0C0CC10	-0.C0C0C47	-0.0000017
24	-0.00000331	-0.0000007	0.0000014	0.C00CC23	-0.CCC0CC6	-0.0000003
25	-C.00000034	-0.0000085	0.00000C7	0.0000008	0.00C0CC6	0.0000002
26	0.00000105	-0.0000030	0.00000C1	0.0	0.00C00C5	0.0000002
27	0.00000052	0.0000018	-0.00C0003	-0.0000001	0.00C0C02	0.0000001
28	-0.00000018	0.0000019	-0.00000C1	-0.0000C02	0.C	-0.0000001
29	-0.00000024	0.0000001	0.0	0.0000C01	-0.C0C0CC1	0.0
3C	-0.00000003	-0.0000007	0.0000002	0.0	-0.C0C0001	0.0
31	0.00000009	-0.0000004	0.0000001	0.0	0.C	0.0
32	0.00000005	0.0	0.0	0.0	0.C	0.0000001
33	-0.00000002	0.0000002	0.00C00C1	0.0	C.0	-0.0000001
34	0.00000001	0.0000001	0.0	0.0	0.C0C00C1	-0.0000001
35	0.00000001	-0.0000001	0.C0C0001	-0.0000C01	-0.C0C0CC1	0.0
SUMS	43.50805689	22.2165158	113.6907577	31.7695884	72.6644648	23.3705904

DAYS 91 THRU 122 JD 2443964.5 TO 2443996.5 DATES APR 1 THRU MAY 2

A = 16.00000000 B = -6.68750000

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	°	E RAD	E RAD	E RAD
0	35.67356672	15.2935685	112.8836818	-4.3808426	49.4044734	16.5338311
1	14.06480700	-0.4660518	0.4329009	7.8852204	-1.1855467	-0.4779824
2	0.30320850	15.6206826	-1.1640441	3.4567857	49.2291608	16.3297277
3	-0.09348003	1.7898896	-2.0386109	-48.3325748	3.4785872	2.2500717
4	-0.14678547	-8.4160824	0.5262275	-2.5580087	-26.5030448	-8.7483564
5	0.07479788	-1.0744675	0.2968989	11.9472428	-1.7789431	-0.8728591
6	0.02264513	1.3566442	0.0885138	1.3086947	4.0839077	1.3250019
7	-0.04394647	0.4910004	0.0560339	-1.3683917	0.7690995	0.2884151
8	-0.00909917	-0.1680970	-0.0501662	-0.4329538	-0.3860445	-0.1179765
9	0.01392909	-0.1229375	-0.0354754	0.1018917	-0.1850470	-0.0639479
10	0.00554229	0.0305469	0.0044200	0.0737633	0.0134821	0.0027008
11	-0.00307342	0.0215501	0.0112621	0.0067086	0.0207021	0.0067269
12	-0.00223308	-0.0096723	0.0018495	-0.0032609	0.0069576	0.0024027
13	0.00072954	-0.0055988	-0.0020829	-0.0042150	0.0015913	0.0006289
14	0.00073146	0.0033727	-0.0009001	-0.0021595	-0.0016666	-0.0005053
15	-0.00022637	0.0023511	0.0000774	0.0004690	-0.0014276	-0.0004861
16	-0.00026062	-0.0009591	0.0001865	0.0008442	-0.0000078	-0.0000223
17	0.00006724	-0.0009519	0.0000822	0.0001301	0.0003856	0.0001251
18	0.00010327	0.0002177	-0.0000001	-0.0001675	0.0001072	0.0000396
19	-0.00001420	0.0003495	-0.0000284	-0.0000725	-0.0000544	-0.0000163
20	-0.00003949	-0.0000366	-0.0000138	0.0000129	-0.0000360	-0.0000122
21	0.00000097	-0.0001244	0.0000036	0.0000171	-0.0000009	-0.0000007
22	0.00001416	0.0	0.0000051	0.0000035	0.0000059	0.0000018
23	0.00000089	0.0000435	0.0000008	-0.0000014	0.0000026	0.0000009
24	-0.00000499	0.0000043	-0.0000010	-0.0000015	0.0	0.0000001
25	-0.00000071	-0.0000150	-0.0000004	-0.0000005	-0.0000005	-0.0000002
26	0.00000176	-0.0000029	-0.0000001	0.0000002	-0.0000005	-0.0000003
27	0.00000041	0.0000049	0.0000001	0.0000003	-0.0000001	0.0
28	-0.00000063	0.0000014	0.0	0.0000001	0.0000001	0.0000001
29	-0.00000023	-0.0000014	0.0	-0.0000001	0.0	0.0
30	0.00000022	-0.0000008	0.0	-0.0000001	-0.0000001	0.0
31	0.00000009	0.0000005	-0.0000001	-0.0000001	-0.0000001	0.0000001
32	-0.00000006	0.0000003	0.0000001	0.0	0.0	0.0
33	-0.00000005	-0.0000001	0.0	0.0000001	0.0000001	0.0
34	0.0	-0.0000002	0.0000001	-0.0000001	0.0000001	-0.0000001
35	0.00000003	0.0	-0.0000001	0.0	0.0	-0.0000001
SUMS	49.86098166	24.3452285	111.0108207	-32.3008661	76.9666426	26.4575086

DAYS 121 THRU 152 JD 2443994.5 TO 2444026.5 DATES MAY 1 THRU JUNE 1

A = 16.00000000 B = -8.56250000

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	'	E RAD	E RAD	E RAD
0	40.29427661	13.7369310	112.0646350	-30.8413424	42.9621693	15.2035874
1	14.09048905	1.1359632	0.1118565	6.8830077	3.5989783	1.1724931
2	0.17234000	13.8712878	-2.1173620	-26.6530940	41.8222852	14.7470114
3	-0.23604798	-6.7205217	-0.8479938	-41.6053048	-23.3586702	-6.7869430
4	-0.04630589	-7.7514915	1.0471652	14.2625598	-22.9297407	-8.0466889
5	0.08394303	1.5801667	0.0519845	10.9167335	5.7425350	1.6344727
6	-0.05973707	1.6596302	-0.0577432	-2.1264031	4.0931536	1.4239046
7	-0.03228689	-0.1841383	0.0696366	-1.6599315	-0.6364796	-0.1689146
8	0.03215475	-0.3215053	-0.0234532	0.2039167	-0.6078212	-0.2085709
9	0.01337229	0.0729070	-0.0319603	0.2451830	0.0658112	0.0155903
10	-0.00945764	0.0500541	0.0075025	-0.0260470	0.0829409	0.0283848
11	-0.00422249	-0.0443466	0.0103172	-0.0276162	-0.0112876	-0.0030507
12	0.00280309	-0.0069056	-0.0017045	0.0059882	-0.0064075	-0.0022851
13	0.00081648	0.0195233	-0.0025528	0.0006183	0.0031808	0.0010475
14	-0.00108256	0.0016104	0.0003596	-0.0019375	-0.0006966	-0.0001860
15	-0.00003617	-0.0069053	0.0004709	0.0007148	-0.0010474	-0.0003693
16	0.00046832	-0.0002765	-0.0000921	0.0006141	0.0004489	0.0001347
17	-0.00004015	0.0021890	-0.0000541	-0.0002628	0.0003053	0.0001092
18	-0.00018850	-0.0001439	0.0000325	-0.0001626	-0.0001293	-0.0000390
19	0.00002618	-0.0006930	-0.0000028	0.0000657	-0.0000728	-0.0000259
20	0.00006727	0.0001578	-0.0000121	0.0000346	0.0000293	0.0000088
21	-0.00001550	0.0002315	0.0000040	-0.0000140	0.0000134	0.0000047
22	-0.00002215	-0.0000887	0.0000038	-0.0000053	-0.0000061	-0.0000019
23	0.00000894	-0.0000780	-0.0000013	0.0000030	-0.0000014	-0.0000006
24	0.00000718	0.0000402	-0.0000009	0.0000003	0.0000012	0.0000004
25	-0.00000463	0.0000248	0.0000005	-0.0000006	-0.0000001	0.0
26	-0.00000233	-0.0000171	0.0000001	0.0000002	-0.0000004	0.0
27	0.00000211	-0.0000070	-0.0000001	0.0000001	0.0000002	0.0000001
28	0.00000070	0.0000071	0.0000001	-0.0000001	0.0000001	0.0
29	-0.00000089	0.0000015	0.0	-0.0000001	-0.0000002	0.0000001
30	-0.00000017	-0.0000030	-0.0000001	0.0000001	-0.0000001	-0.0000001
31	0.00000037	-0.0000002	0.0000001	-0.0000001	0.0000001	-0.0000001
32	0.00000004	0.0000013	0.0	0.0	0.0	-0.0000001
33	-0.00000015	0.0	-0.0000001	0.0000001	0.0	0.0
34	0.00000001	-0.0000008	0.0	0.0	0.0	-0.0000001
35	0.00000004	0.0000001	-0.0000001	0.0000001	0.0	0.0
SUMS	54.30132530	17.0936045	110.2810356	-70.4226818	50.8194916	19.0096735

CHEBYSHEV APPROXIMATION OF LUNAR COORDINATES FOR YEAR 1979

DAYS 152 THRU 183 JD 2444025.5 TO 2444057.5 DATES JUNE 1 THRU JULY 2

A = 16.00000000 B = -10.50000000

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	'	E RAD	E RAD	E RAD
0	46.50325615	5.3805203	111.9470413	-53.1395854	14.3244623	6.4264629
1	14.07665770	2.5605969	-0.3501943	1.1745382	7.2056782	2.5456962
2	-0.13569478	4.3579633	-2.2576218	-50.7754555	9.2921951	4.6581382
3	-0.31277642	-14.0606754	1.0738584	-9.6171913	-44.7000308	-14.7923726
4	0.09362744	-2.2264929	1.0229834	27.7333581	-4.7379172	-2.4219903
5	-0.00420628	4.0463435	-0.3925862	1.9229363	11.6990161	3.8705410
6	-0.05909087	0.1952173	0.0233267	-4.8658133	0.3344279	0.2567948
7	0.05441600	-0.7904668	0.1200437	0.0754475	-1.7290826	-0.5823543
8	0.02294823	0.1098105	-0.0702363	0.6923446	0.1434538	0.0278139
9	-0.02419200	0.1046140	-0.0256377	-0.1116254	0.2428592	0.0848368
10	-0.00456243	-0.0858307	0.0267479	-0.0882788	-0.0669208	-0.0199141
11	0.00734531	0.0175003	0.0021411	0.0394984	-0.0232512	-0.0089566
12	-0.00054931	0.0358262	-0.0076176	0.0036160	0.0197708	0.0065468
13	-0.00152278	-0.0186585	0.0010238	-0.0102628	-0.0020303	-0.0003861
14	0.00102759	-0.0096309	0.0016341	0.0026338	-0.0044548	-0.0015765
15	0.00002363	0.0083179	-0.0006783	0.0020010	0.0018755	0.0005730
16	-0.00055485	0.0010119	-0.0002114	-0.0012153	0.0007078	0.0002741
17	0.00017731	-0.0026615	0.0002485	-0.0002328	-0.0006486	-0.0002116
18	0.00019019	0.0006609	-0.0000205	0.0003544	-0.0000309	-0.0000210
19	-0.00011419	0.0005806	-0.0000661	-0.0000237	0.0001638	0.0000558
20	-0.00003505	-0.0005261	0.0000256	-0.0000786	-0.0000312	-0.0000081
21	0.00004835	-0.0000183	0.0000122	0.0000251	-0.0000311	-0.0000112
22	-0.00000690	0.0002258	-0.0000105	0.0000121	0.0000156	0.0000049
23	-0.00001476	-0.0000647	-0.0000006	-0.0000096	0.0000032	0.0000014
24	0.00000978	-0.0000647	0.0000031	-0.0000002	-0.0000048	-0.0000016
25	0.00000239	0.0000425	-0.0000007	0.0000025	0.0000005	0.0000001
26	-0.00000522	0.0000078	-0.0000007	-0.0000007	0.0000011	0.0000005
27	0.00000075	-0.0000177	0.0000004	-0.0000005	-0.0000005	-0.0000001
28	0.00000186	0.0000042	0.0	0.0000003	-0.0000001	-0.0000001
29	-0.00000086	0.0000051	-0.0000002	0.0000001	0.0000002	0.0000001
30	-0.00000038	-0.0000038	0.0	-0.0000001	0.0	0.0000001
31	0.00000047	-0.0000009	-0.0000001	0.0000001	-0.0000001	0.0
32	-0.00000006	0.0000020	0.0	0.0	0.0	0.0
33	-0.00000016	-0.0000001	-0.0000001	0.0	0.0	0.0
34	0.00000010	-0.0000006	0.0000001	0.0	0.0000001	0.0000001
35	0.00000002	0.0000005	0.0	0.0	0.0	0.0
SUMS	60.21640597	-0.3758621	111.1142072	-86.9630055	-7.9998038	0.0499365

DAYS 182 THRU 213 JD 2444055.5 TO 2444087.5 DATES JULY 1 THRU AUG 1

A = 16.00000000 B = -12.37500000

TERM	R A H	DEC DEG	H P '	X E RAD	Y E RAD	Z E RAD
0	51.00353361	-2.7403472	112.5867838	-52.0158623	-12.0064000	-2.2735224
1	14.05893874	2.3362516	-0.6523871	-3.7478362	6.2304840	2.3357576
2	-0.37770399	-4.7559992	-1.5569982	-47.7349155	-20.0367096	-5.1319176
3	-0.22268501	-14.0169096	2.2537755	19.2543193	-41.7285307	-14.7066391
4	0.16683338	3.0568248	0.5412597	25.5401777	11.4913843	3.0044443
5	-0.03813652	3.5492834	-0.6336641	-5.9363860	10.0838796	3.5827095
6	0.00812024	-1.1687956	0.2168268	-3.6693352	-2.7588087	-0.8043369
7	0.05954891	-0.3796304	0.1141925	1.3882013	-0.9528318	-0.3654359
8	-0.02273044	0.3388331	-0.1294321	0.2005904	0.6292427	0.2048716
9	-0.01803805	-0.0683918	0.0002248	-0.2958080	-0.0204848	0.0028384
10	0.01156605	-0.0361710	0.0360892	0.0564924	-0.1130941	-0.0399042
11	0.00170366	0.0615107	-0.0114135	0.0417778	0.0448043	0.0137009
12	-0.00321186	-0.0195395	-0.0061538	-0.0296385	0.0097986	0.0042785
13	0.00104724	-0.0183040	0.0052513	0.0000420	-0.0153170	-0.0051571
14	0.00010243	0.0138189	-0.0001785	0.0078040	0.0025786	0.0006086
15	-0.00060145	0.0013061	-0.0014451	-0.0025028	0.0031353	0.0011385
16	0.00038327	-0.0045354	0.0006007	-0.0011936	-0.0016492	-0.0005152
17	0.00010990	0.0014135	0.0002129	0.0010166	-0.0002651	-0.0001231
18	-0.00021164	0.0005745	-0.0002594	-0.0000299	0.0005062	0.0001713
19	0.00003872	-0.0007561	0.0000290	-0.0002510	-0.0001022	-0.0000259
20	0.00005543	0.0002611	0.0000677	0.0000940	-0.0000974	-0.0000359
21	-0.00003557	0.0001576	-0.0000326	0.0000343	0.0000610	0.0000193
22	0.00000115	-0.0001916	-0.0000086	-0.0000372	0.0000052	0.0000030
23	0.00001159	0.0000275	0.0000126	0.0000034	-0.0000182	-0.0000062
24	-0.00000817	0.0000574	-0.0000019	0.0000087	0.0000048	0.0000012
25	-0.00000020	-0.0000346	-0.0000030	-0.0000039	0.0000031	0.0000013
26	0.00000380	-0.0000026	0.0000018	-0.0000010	-0.0000024	-0.0000007
27	-0.00000176	0.0000128	0.0000003	0.0000016	0.0000001	-0.0000001
28	-0.00000069	-0.0000061	-0.0000005	-0.0000002	0.0000007	0.0000003
29	0.00000097	-0.0000011	0.0000003	-0.0000003	-0.0000002	0.0
30	-0.00000022	0.0000030	0.0000003	0.0000001	-0.0000001	-0.0000001
31	-0.00000024	-0.0000013	-0.0000001	0.0	0.0000002	-0.0000001
32	0.00000023	-0.0000009	0.0	-0.0000002	0.0	0.0000001
33	-0.00000004	0.0000006	0.0	0.0	-0.0000001	0.0000001
34	-0.00000006	-0.0000002	0.0000001	0.0	0.0	0.0
35	0.00000007	-0.0000002	-0.0000001	0.0000001	0.0	0.0
SUMS	64.62863348	-13.8492818	112.7633507	-66.9432381	-49.1384229	-14.1770760

DAYS 213 THRU 244 JD 2444086.5 TO 2444118.5 DATES AUG 1 THRU SEPT 1

A = 16.00000000 B = -14.31250000

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	°	E RAD	E RAD	E RAD
0	57.36318059	-12.0442579	114.3285271	-25.6328103	-38.2074338	-11.8960964
1	14.03472944	0.5947840	-0.7656341	-7.5119974	1.1062073	0.6801525
2	-0.49568146	-14.6244733	0.3787376	-16.7831402	-47.3702679	-15.2939418
3	0.08703294	-6.2422304	2.8847363	46.4445420	-13.7900349	-6.3003439
4	0.19292529	7.9828692	-0.4941669	7.9832748	25.4766330	8.2528243
5	-0.00976071	0.5656804	-0.4127283	-11.3422708	1.9033544	1.0427048
6	0.04636801	-1.3159082	0.3943022	0.2220707	-3.7221002	-1.2541445
7	-0.01754800	0.4771219	-0.1086244	1.1087869	0.6729428	0.1863888
8	-0.02522833	0.0597723	-0.1054887	-0.4996532	0.1974264	0.0838573
9	0.01341536	-0.1055745	0.0636384	0.0293126	-0.2365794	-0.0803974
10	0.00137964	0.0533204	-0.0010808	0.0945104	0.0657818	0.0187047
11	-0.00420885	-0.0188184	-0.0159808	-0.0523496	0.0218350	0.0091902
12	0.00122497	-0.0127667	0.0083136	0.0014325	-0.0280455	-0.0094593
13	0.00018555	0.0144276	0.0004964	0.0133277	0.0066192	0.0017447
14	-0.00014762	-0.0034200	-0.0026343	-0.0057609	0.0042444	0.0016302
15	0.00021114	-0.0027877	0.0011923	-0.0007427	-0.0033179	-0.0010863
16	-0.00016883	0.0022854	0.0002151	0.0017062	0.0004552	0.0000908
17	-0.00000122	-0.0003118	-0.0004550	-0.0005995	0.0006163	0.0002279
18	0.00007982	-0.0003333	0.0001545	-0.0001574	-0.0004040	-0.0001292
19	-0.00003954	0.0002377	0.0000570	0.0002307	0.0000290	0.0000016
20	-0.00000699	-0.0000855	-0.0000739	-0.0000670	0.0000948	0.0000340
21	0.00001288	-0.0000007	0.0000195	-0.0000315	-0.0000522	-0.0000164
22	-0.00000477	0.0000354	0.0000126	0.0000328	-0.0000019	-0.0000017
23	0.00000057	-0.0000269	-0.0000120	-0.0000063	0.0000151	0.0000052
24	0.00000082	0.0000035	0.0000021	-0.0000060	-0.0000061	-0.0000019
25	-0.00000130	0.0000070	0.0000026	0.0000043	-0.0000012	-0.0000006
26	0.00000077	-0.0000043	-0.0000019	-0.0000003	0.0000020	0.0000007
27	0.00000011	0.0000007	0.0000003	-0.0000009	-0.0000006	-0.0000002
28	-0.00000040	0.0000006	0.0000005	0.0000006	-0.0000001	-0.0000001
29	0.00000016	-0.0000007	-0.0000003	-0.0000001	0.0000004	0.0000001
30	0.0	0.0000002	0.0	-0.0000003	-0.0000002	-0.0000001
31	-0.00000006	-0.0000001	0.0000001	0.0000001	0.0	0.0
32	0.00000003	-0.0000002	-0.0000001	0.0	0.0000001	0.0
33	0.0	0.0	0.0	0.0	0.0	0.0
34	0.0	-0.0000001	0.0	0.0	0.0	0.0
35	0.0	0.0	-0.0000001	0.0	0.0	0.0
SUMS	71.18795001	-24.6204544	116.1535266	-5.9304021	-73.9019887	-24.5580620

DAYS 244 THRU 275 JD 2444117.5 TO 2444149.5 DATES SEPT 1 THRU OCT 2

A = 16.00000000 B = -16.25000000

TERM	R A H	DEC DEG	H P °	X E RAD	Y E RAD	Z E RAD
0	64.02272733	-13.0406494	116.1386503	13.4577455	-36.5698924	-12.7826564
1	14.00414882	-1.2455782	-0.5876510	-5.9119863	-4.5782244	-1.3523375
2	-0.29485558	-15.0474429	2.3386087	26.4162452	-43.1450193	-15.4306689
3	0.33035310	6.4748711	2.0201606	42.4860918	24.6030839	6.7072533
4	0.13135941	7.5283654	-1.2604142	-14.5141697	22.2206350	7.9892722
5	-0.02952326	-1.8336198	0.0534179	-8.7000847	-6.1996311	-1.7555032
6	-0.03763401	-0.2496366	0.2119342	2.3121019	-1.8587182	-0.7084172
7	-0.02553184	0.2718209	-0.2344684	-0.0574577	0.6673030	0.2247455
8	0.01377973	-0.2343445	0.0137668	-0.1361585	-0.3031632	-0.0966862
9	0.00300314	0.0027988	0.0403650	0.1848077	0.0310319	0.0036755
10	-0.00292434	0.0211524	-0.0211042	-0.0564755	0.0597338	0.0220798
11	0.00203311	-0.0104486	0.0060589	-0.0084522	-0.0380782	-0.0124484
12	0.00029281	0.0075088	0.0033628	0.0198045	0.0067691	0.0015452
13	-0.00056938	-0.0000699	-0.0035345	-0.0071842	0.0063421	0.0023887
14	-0.00005645	-0.0007609	0.0011417	-0.0008733	-0.0039424	-0.0012891
15	0.00003506	0.0007968	0.0003269	0.0016989	0.0008155	0.0002102
16	0.00001980	-0.0005834	-0.0005077	-0.0008595	0.0003787	0.0001590
17	-0.00001866	-0.0000999	0.0001844	0.0000732	-0.0004556	-0.0001546
18	0.00000517	0.0001785	0.0000205	0.0001811	0.0001555	0.0000449
19	0.00001321	-0.0000428	-0.0000627	-0.0001171	0.0000268	0.0000130
20	-0.00000543	-0.0000150	0.0000328	0.0000201	-0.0000542	-0.0000186
21	-0.00000239	0.0000214	-0.0000017	0.0000186	0.0000233	0.0000072
22	0.00000157	-0.0000018	-0.0000082	-0.0000154	0.0000007	0.0000008
23	-0.00000020	-0.0000049	0.0000055	0.0000040	-0.0000063	-0.0000023
24	-0.00000033	0.0000009	-0.0000008	0.0000020	0.0000034	0.0000010
25	0.00000010	0.0000006	-0.0000011	-0.0000021	-0.0000001	-0.0000001
26	0.00000014	-0.0000004	0.0000008	0.0000005	-0.0000008	-0.0000002
27	-0.00000003	0.0000001	-0.0000003	0.0000001	0.0000004	0.0000003
28	-0.00000003	0.0	-0.0000001	-0.0000002	-0.0000001	0.0
29	0.00000004	-0.0000002	0.0000002	0.0000001	0.0	0.0
30	0.0	0.0000003	-0.0000001	0.0	0.0	0.0
31	0.0	0.0	0.0	-0.0000001	0.0	0.0000001
32	0.00000001	-0.0000001	0.0	0.0000001	0.0	0.0
33	-0.00000001	0.0000001	0.0000001	0.0000001	0.0000001	0.0000001
34	0.00000002	0.0	0.0	-0.0000001	-0.0000001	0.0
35	0.0	0.0000001	0.0000002	0.0	0.0	0.0
SUMS	78.11665063	-17.3557831	118.7202833	55.4849588	-45.1048832	-17.1887859

CHEBYSHEV APPROXIMATION OF LUNAR COORDINATES FOR YEAR 1979

DAYS 274 THRU 305   JD 2444147.5 TO 2444179.5   DATES OCT 1 THRU NOV 1

A = 16.00000000   B = -18.12500000

TERM	R A H	DEC DEG	H P "	X E RAD	Y E RAD	Z E RAD
0	68.91118785	-7.1873934	116.6180417	34.4796794	-17.0765903	-7.0818267
1	13.98066335	-2.0501009	-0.3990606	-2.1714275	-6.7108706	-2.2633035
2	-0.09753119	-8.2510603	2.7914267	48.1901701	-20.1090567	-8.5462285
3	0.32434902	13.6844764	0.7016031	19.6798131	43.5228812	13.9871932
4	0.03425648	4.0399146	-1.3969009	-25.4101789	10.1313338	4.3868743
5	-0.10917537	-2.7142762	0.2883716	-3.8227294	-9.4778922	-3.0478796
6	-0.03920026	-0.0743875	0.0883190	2.6440425	-0.7055655	-0.3419103
7	0.03047213	-0.1390295	-0.1920927	-0.0863159	0.2589128	0.0884842
8	0.01457259	-0.1396654	0.0405438	0.1957363	-0.1193962	-0.0472591
9	-0.00458030	0.1210301	0.0156540	0.0380729	0.1528533	0.0502154
10	0.00029746	0.0199356	-0.0085882	-0.0741896	-0.0127082	-0.0015035
11	-0.00060037	-0.0183627	0.0082642	0.0209523	-0.0222395	-0.0082668
12	-0.00145266	0.0009761	-0.0017252	0.0037973	0.0128098	0.0041724
13	0.00035153	-0.0006932	-0.0016621	-0.0055401	-0.0014285	-0.0002731
14	0.00044483	-0.0012739	0.0010923	0.0016444	-0.0011098	-0.0004344
15	-0.00004523	0.0007385	-0.0002591	-0.0003176	0.0007932	0.0002785
16	-0.00003320	0.0005155	-0.0000984	-0.0002429	-0.0004708	-0.0001495
17	0.00000582	-0.0000671	0.0001140	0.0003007	0.0000186	-0.0000051
18	-0.00002718	-0.0001107	-0.0000550	-0.0000729	0.0001109	0.0000400
19	-0.00000570	-0.0000167	0.0000046	-0.0000238	-0.0000509	-0.0000160
20	0.00001257	-0.0000047	0.0000144	0.0000246	0.0000073	0.0000016
21	0.00000208	-0.0000032	-0.0000084	-0.0000105	0.0000057	0.0000022
22	-0.00000203	0.0000123	0.0000013	0.0000011	-0.0000056	-0.0000019
23	0.00000015	0.0000049	0.0000010	0.0000020	0.0000023	0.0000006
24	-0.00000027	-0.0000042	-0.0000010	-0.0000017	0.0	0.0000001
25	-0.00000041	-0.0000011	0.0000004	0.0000004	-0.0000007	-0.0000002
26	0.00000022	0.0000006	0.0000001	0.0000004	0.0000004	0.0000001
27	0.00000016	-0.0000003	-0.0000001	-0.0000002	0.0	0.0000001
28	-0.00000006	0.0	0.0	0.0	0.0	0.0
29	-0.00000002	0.0000002	-0.0000001	0.0	0.0	0.0000001
30	0.00000002	-0.0000001	0.0	0.0000001	-0.0000001	0.0000001
31	-0.00000001	-0.0000003	0.0000001	0.0	0.0	0.0
32	0.0	0.0	0.0000001	-0.0000001	0.0	0.0
33	-0.00000001	0.0	0.0000002	0.0	0.0000001	0.0
34	-0.00000001	-0.0000001	0.0000001	0.0000001	0.0	0.0
35	0.0	-0.0000001	-0.0000002	0.0000001	0.0	0.0
SUMS	83.04396198	-2.7088468	118.5530007	73.6831867	-0.1576562	-2.8217953

CHEBYSHEV APPROXIMATION OF LUNAR COORDINATES FOR YEAR 1979

DAYS 305 THRU 336   JD 2444178.5 TO 2444210.5   DATES NOV 1 THRU DEC 2

A = 16.00000000   B = -20.06250000

TERM	R A	DEC	H P	X	Y	Z
	H	DEG	"	E RAD	E RAD	E RAD
0	75.54474443	5.6119364	116.0733287	35.4016455	20.9908512	5.7402509
1	13.99303692	-2.1806775	-0.0959756	3.5473376	-6.1853093	-2.3167562
2	0.10383678	5.6402273	2.1595027	47.4711877	21.4242045	5.4996034
3	0.22100831	14.7774386	-1.2335061	-21.6782434	42.1678817	15.2870802
4	-0.12247983	-2.7857959	-0.9148823	-25.1334901	-11.2736415	-2.8146561
5	-0.09227935	-3.0810240	0.5192123	4.3268907	-9.5023511	-3.4113300
6	0.08021913	-0.0798625	-0.0506540	3.0003897	0.7987706	0.1423494
7	0.03898356	0.0541235	-0.1100965	0.1983183	0.5911486	0.1923981
8	-0.02193749	0.2626143	0.0328004	-0.0576350	0.2752255	0.0970800
9	-0.01021382	0.0420290	0.0106396	-0.1745380	0.0086320	0.0100948
10	-0.00078947	-0.0943390	0.0069217	-0.0011421	-0.0730189	-0.0248255
11	0.00169582	-0.0106494	-0.0004365	0.0275045	0.0044848	0.0004013
12	0.00250033	0.0174373	-0.0040098	-0.0030345	0.0076965	0.0027367
13	-0.00022807	0.0063795	0.0002407	-0.0021368	-0.0006997	-0.0001463
14	-0.00098504	0.0005201	0.0005682	-0.0004321	-0.0005990	-0.0001874
15	-0.00007627	-0.0030290	0.0000036	0.0002889	-0.0005743	-0.0002085
16	0.00019605	-0.0015377	-0.0000173	0.0004223	0.0001650	0.0000392
17	0.00010729	0.0007977	-0.0000504	-0.0000863	0.0002037	0.0000729
18	0.00000613	0.0006057	0.0000068	-0.0000891	-0.0000319	-0.0000071
19	-0.00005541	-0.0000318	0.0000179	0.0000049	-0.0000294	-0.0000103
20	-0.00002178	-0.0001538	-0.0000030	0.0000096	-0.0000037	-0.0000017
21	0.00001533	-0.0000791	-0.0000030	0.0000050	0.0000030	0.0000009
22	0.00001040	0.0000214	-0.0000002	-0.0000013	0.0000030	0.0000012
23	-0.00000054	0.0000430	0.0	-0.0000017	-0.0000006	-0.0000002
24	-0.00000335	0.0000048	0.0000004	0.0000002	-0.0000006	-0.0000003
25	-0.00000174	-0.0000122	-0.0000001	0.0000003	0.0000001	0.0
26	0.00000069	-0.0000054	-0.0000002	0.0	0.0000001	0.0000001
27	0.00000100	0.0000010	0.0	0.0	0.0	0.0
28	0.00000004	0.0000027	0.0	0.0	0.0	-0.0000001
29	-0.00000028	0.0000007	0.0	0.0	0.0	0.0
30	-0.00000014	-0.0000006	-0.0000001	0.0	0.0000001	-0.0000001
31	0.00000002	-0.0000006	0.0	-0.0000001	0.0	0.0
32	0.00000007	0.0	0.0	-0.0000001	0.0	-0.0000001
33	0.0	0.0000002	0.0000001	0.0000001	0.0	0.0
34	-0.00000003	0.0	0.0000001	0.0	0.0	0.0
35	0.0	0.0	0.0	0.0	0.0	0.0
SUMS	89.73728969	18.1769847	116.3936081	46.9231747	59.2330104	18.4039792

CHEBYSHEV APPROXIMATION OF LUNAR COORDINATES FOR YEAR 1979

DAYS 335 THRU 366 JD 2444208.5 TO 2444240.5 DATES DEC 1 THRU JAN 1

A = 16.00000000 B = -21.93750000

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	°	E RAD	E RAD	E RAD
0	32.34566850	13.1202314	114.7651418	15.5854107	41.7708467	13.6648526
1	14.06292781	-1.4404546	0.0982506	6.5401159	-3.2045191	-1.4430413
2	0.21106435	13.5113468	0.6690074	25.4384460	42.9575755	13.7101786
3	0.09951542	8.9111819	-2.0147812	-43.3769662	21.8475057	9.4561623
4	-0.18633223	-7.0038033	-0.2031921	-13.9533622	-22.9531872	-7.2371587
5	0.02026769	-2.4200420	0.6982477	9.7134512	-5.8548474	-2.4425845
6	0.11194378	0.5319957	-0.0755098	2.6229848	2.6538304	0.7846566
7	-0.02213882	0.5278191	-0.1550296	-0.4624903	1.0301144	0.3740053
8	-0.03962031	0.1613964	0.0087458	-0.4870821	0.0613414	0.0438397
9	-0.00056677	-0.1916258	0.0331056	-0.1054831	-0.2105422	-0.0674461
10	0.00864033	-0.0661395	0.0118090	0.0973071	-0.0572233	-0.0240403
11	0.00438132	0.0611733	-0.0071285	0.0301609	0.0382650	0.0117410
12	-0.00200088	0.0256972	-0.0055496	-0.0150342	0.0136188	0.0053512
13	-0.00234084	-0.0109848	0.0011079	-0.0074965	-0.0048403	-0.0013153
14	0.00051390	-0.0117355	0.0015173	0.0013555	-0.0037868	-0.0013612
15	0.00088739	-0.0000815	0.0000440	0.0021412	0.0001998	-0.0000295
16	0.00001112	0.0045983	-0.0003651	0.0001236	0.0010362	0.0003501
17	-0.00030163	0.0009564	-0.0001034	-0.0005242	0.0001404	0.0000721
18	-0.00010453	-0.0014153	0.0000829	-0.0001212	-0.0002239	-0.0000715
19	0.00009452	-0.0006033	0.0000453	0.0000979	-0.0000745	-0.0000299
20	0.00006655	0.0003282	-0.0000143	0.0000488	0.0000362	0.0000102
21	-0.00002298	0.0003054	-0.0000151	-0.0000128	0.0000261	0.0000094
22	-0.00002999	-0.0000409	0.0000005	-0.0000150	-0.0000033	-0.0000004
23	0.00000136	-0.0001281	0.0000043	0.0000001	-0.0000073	-0.0000025
24	0.00001178	-0.0000143	0.0000008	0.0000037	-0.0000006	-0.0000003
25	0.00000273	0.0000442	-0.0000011	0.0000007	0.0000016	0.0000006
26	-0.00000406	0.0000156	-0.0000004	-0.0000007	0.0000005	0.0000001
27	-0.00000215	-0.0000126	0.0000003	-0.0000003	-0.0000003	-0.0000002
28	0.00000112	-0.0000092	0.0000001	0.0000001	-0.0000002	0.0000001
29	0.00000111	0.0000025	0.0	0.0000002	0.0000001	0.0000001
30	-0.00000014	0.0000042	-0.0000001	0.0	0.0	0.0
31	-0.00000049	0.0000002	0.0	0.0	0.0	0.0
32	-0.00000007	-0.0000015	0.0000001	-0.0000001	0.0	0.0000001
33	0.00000018	-0.0000006	-0.0000001	0.0	-0.0000001	0.0000001
34	0.00000007	0.0000006	0.0000001	0.0000001	0.0	0.0
35	-0.00000006	0.0000003	-0.0000001	0.0	0.0	0.0
SUMS	46.61253508	25.7100049	113.8254210	1.6230596	78.0852823	26.8341485

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1979
MERCURY AND VENUS

DAYS 1 THRU 95 JD 2443874.5 TO 2443969.5 DATES JAN 1 THRU APR 5

A = 47.50000000 B = -1.02105263

TERM	MERCURY R A (H)	MERCURY DEC (DEG)	MERCURY DISTANCE (AU)	VENUS R A (H)	VENUS DEC (DEG)	VENUS DISTANCE (AU)
0	42.9364325	-20.623274	2.0847585	38.1035737	-32.442769	1.7869239
1	3.6006026	15.235784	-0.3724531	3.6694589	2.897766	0.3466851
2	-1.0825111	-0.994390	-0.1969909	0.0865340	4.331464	-0.0071480
3	-0.4643137	-6.113469	0.1178436	-0.0594888	0.247743	-0.0017251
4	0.0312930	-0.993953	0.0694441	0.0051711	-0.205330	0.0002406
5	0.1269109	1.044464	0.0092021	0.0017504	0.008287	-0.0000758
6	0.0790225	0.778301	-0.0163275	0.0001976	0.003554	0.0000095
7	0.0060341	0.161663	-0.0094044	-0.0001889	0.000020	-0.0000144
8	-0.0196046	-0.123736	0.0008343	-0.0000835	-0.000272	0.0000075
9	-0.0127679	-0.101359	0.0029909	0.0000432	-0.000002	0.0000169
10	-0.0012321	-0.021275	0.0008280	0.0000519	0.000082	-0.0000044
11	0.0026053	0.010312	-0.0006210	-0.0000186	0.000036	-0.0000071
12	0.0015458	0.006690	-0.0004364	-0.0000153	-0.000032	0.0000016
13	0.0001606	0.001124	0.0000803	0.0000071	-0.000022	0.0000015
14	-0.0001786	0.001234	0.0001766	0.0000006	0.000009	-0.0000007
15	-0.0000636	0.001725	0.0000218	-0.0000021	0.000005	-0.0000002
16	-0.0000176	0.000332	-0.0000640	0.0000008	-0.000009	-0.0000001
17	-0.0000497	-0.000990	-0.0000317	-0.0000018	0.000005	0.0000001
18	-0.0000374	-0.000888	0.0000152	0.0000011	0.000008	0.0000004
19	0.0000094	-0.000095	0.0000192	0.0000030	-0.000006	0.0000001
20	0.0000277	0.000335	0.0000012	-0.0000018	-0.000006	-0.0000004
21	0.0000129	0.000234	-0.0000074	-0.0000021	0.000001	0.0000001
22	-0.0000040	0.000002	-0.0000032	0.0000015	0.000002	0.0000001
23	-0.0000082	-0.000087	0.0000016	0.0000008	-0.000003	0.0
24	-0.0000031	-0.000040	0.0000019	-0.0000006	-0.000001	-0.0000001
25	0.0000018	0.000009	0.0000002	-0.0000002	0.0	0.0
26	0.0000020	0.000013	-0.0000007	0.0000002	0.0	0.0
27	0.0000003	0.000002	-0.0000003	0.0000001	0.0	-0.0000001
28	-0.0000005	-0.000005	0.0000002	0.0000001	0.000003	0.0000001
29	-0.0000001	-0.000001	0.0000002	-0.0000001	0.000002	0.0
30	-0.0000002	0.000001	0.0	-0.0000003	-0.000002	0.0
31	0.0000002	0.000004	-0.0000002	0.0000001	0.000003	0.0
32	0.0	-0.000001	-0.0000001	0.0000002	-0.000001	0.0
33	-0.0000002	0.0	0.0	-0.0000002	0.000001	0.0
34	0.0000001	0.000001	0.0	-0.0000001	0.000001	0.0
35	0.0	-0.000002	-0.0000001	0.0000001	0.000001	0.0
36	0.0000003	-0.000001	0.0	0.0000001	-0.000001	0.0
37	0.0	0.000002	0.0	0.0000001	-0.000001	-0.0000001
38	-0.0000002	0.0	0.0	-0.0000002	-0.000002	0.0000001
39	-0.0000001	-0.000003	0.0000001	0.0	-0.000001	0.0
SUMS	45.2038691	-11.731337	1.6898790	41.8069921	-25.159467	2.1249111

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1979
MERCURY AND VENUS

DAYS 91 THRU 185 JD 2443964.5 TO 2444059.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.91578947

TERM	MERCURY R A H	MERCURY DEC DEG	MERCURY DISTANCE AU	VENUS R A H	VENUS DEC DEG	VENUS DISTANCE AU
0	55.2778092	22.846099	1.8868357	52.0748993	16.255194	2.9080678
1	4.9088270	13.596165	0.1616044	3.7268688	17.908054	0.2337714
2	0.6934067	-2.943500	-0.2693424	0.0943757	-1.990310	-0.0227797
3	-0.4418111	-5.455437	-0.0718807	0.0270711	-0.840083	-0.0015358
4	-0.1067710	0.648183	0.0396252	-0.0060082	0.003190	-0.0000025
5	-0.0234228	0.729392	0.0203542	-0.0018432	0.006380	0.0000040
6	0.0411942	0.200152	-0.0007757	-0.0000179	0.002571	0.0000011
7	0.0118636	-0.117925	-0.0079550	0.0000257	0.000446	-0.0000134
8	-0.0097181	-0.110021	-0.0013043	-0.0000322	-0.000270	0.0000066
9	-0.0053625	0.018141	0.0020576	0.0000190	0.000043	0.0000166
10	0.0007465	0.033041	0.0010744	0.0000297	0.000111	-0.0000044
11	0.0024088	0.007555	-0.0003845	-0.0000079	-0.000048	-0.0000071
12	0.0003428	-0.010301	-0.0005070	-0.0000077	-0.000030	0.0000012
13	-0.0007142	-0.005589	-0.0000116	0.0000016	0.000012	0.0000013
14	-0.0003524	0.001984	0.0001822	0.0000017	0.000010	-0.0000003
15	0.0001534	0.002644	0.0000623	-0.0000002	0.000001	0.0
16	0.0001834	0.000132	-0.0000504	-0.0000010	-0.000003	0.0
17	-0.0000030	-0.000989	-0.0000397	0.0	0.000002	0.0000002
18	-0.0000713	-0.000362	0.0000071	0.0000002	-0.000009	-0.0000001
19	-0.0000216	0.000261	0.0000178	-0.0000001	-0.000004	-0.0000003
20	0.0000222	0.000230	0.0000030	0.0000008	0.000005	0.0000001
21	0.0000155	-0.000032	-0.0000060	-0.0000001	0.000005	0.0000002
22	-0.0000041	-0.000102	-0.0000032	-0.0000005	-0.000003	0.0
23	-0.0000075	-0.000022	0.0000014	0.0000001	-0.000001	0.0
24	-0.0000010	0.000037	0.0000019	0.0000002	0.000002	0.0
25	0.0000029	0.000023	0.0	0.0000001	0.000002	0.0
26	0.0000013	-0.000011	-0.0000009	-0.0000001	-0.000002	0.0
27	-0.0000007	-0.000009	-0.0000002	-0.0000001	-0.000002	0.0
28	-0.0000006	0.000002	0.0000002	0.0	0.000002	0.0
29	0.0000002	0.000006	0.0000002	-0.0000001	0.0	-0.0000001
30	0.0	0.000002	0.0	-0.0000003	-0.000001	0.0000001
31	-0.0000001	-0.000003	-0.0000001	0.0000001	-0.000002	0.0
32	0.0000001	0.0	0.0	0.0000001	-0.000001	0.0
33	-0.0000001	0.000001	0.0	0.0000002	-0.000001	0.0
34	-0.0000002	0.0	0.0	-0.0000001	0.000001	0.0
35	0.0	0.0	0.0	-0.0000001	0.0	0.0
36	0.0000001	0.0	0.0	0.0	0.0	0.0
37	-0.0000001	0.0	-0.0000001	0.0	0.0	0.0
38	0.0	-0.000003	0.0000001	0.0000002	0.0	0.0
39	0.0000001	0.0	-0.0000001	-0.0000001	0.000002	0.0
SUMS	60.3487156	29.439744	1.7595658	55.9153747	31.345263	3.1175269

DAYS 182 THRU 276 JD 2444055.5 TO 2444150.5 DATES JULY 1 THRU OCT 3

A = 47.50000000 B = -4.83157895

	MERCURY R A	MERCURY DEC	MERCURY DISTANCE	VENUS R A	VENUS DEC	VENUS DISTANCE
TERM	H	DEG	AU	H	DEG	AU
0	20.4207465	18.079087	2.0316187	19.0281771	23.144103	3.3952627
1	2.3948868	-12.347965	0.3792631	3.8846341	-15.812991	0.0142966
2	1.1212470	-5.784379	0.1177313	-0.1117828	-3.796383	-0.0307318
3	0.1184936	-3.396792	-0.1784279	0.0057844	0.767629	0.0006114
4	-0.4302639	2.004774	-0.0248976	0.0121387	0.060020	0.0001624
5	0.0569766	0.933398	0.0412408	-0.0010384	-0.017903	-0.0000272
6	0.1196740	-0.602447	0.0069373	-0.0003742	0.002752	-0.0000024
7	-0.0320064	-0.176317	-0.0102809	0.0001027	0.000554	-0.0000127
8	-0.0286027	0.133954	-0.0026093	-0.0000457	-0.000104	0.0000090
9	0.0115838	0.030616	0.0021251	0.0000118	-0.000039	0.0000156
10	0.0045198	-0.012605	0.0010826	0.0000248	-0.000072	-0.0000060
11	-0.0026899	-0.005698	-0.0001998	-0.0000096	0.000016	-0.0000060
12	0.0002481	-0.008603	-0.0004568	-0.0000073	0.000032	0.0000017
13	0.0000174	0.002345	-0.0001190	0.0000016	0.000008	0.0000017
14	-0.0005679	0.006970	0.0001801	0.0000011	-0.000008	-0.0000001
15	0.0003925	-0.001405	0.0001028	0.0000010	-0.000006	-0.0000003
16	0.0002815	-0.003283	-0.0000618	-0.0000001	0.000002	0.0000002
17	-0.0002599	0.000662	-0.0000540	0.0000010	-0.000008	-0.0000002
18	-0.0000976	0.001187	0.0000162	0.0	0.000006	-0.0000004
19	0.0001120	-0.000204	0.0000235	-0.0000021	0.000011	0.0000004
20	0.0000271	-0.000334	-0.0000016	-0.0000001	-0.000004	0.0000003
21	-0.0000352	0.000008	-0.0000090	0.0000015	-0.000006	-0.0000003
22	-0.0000068	0.000063	-0.0000015	0.0000002	0.000001	-0.0000001
23	0.0000066	0.000038	0.0000029	-0.0000007	0.000003	0.0
24	0.0000019	-0.000001	0.0000015	-0.0000002	0.0	0.0
25	0.0000005	-0.000034	-0.0000008	0.0000003	-0.000001	-0.0000001
26	-0.0000010	-0.000010	-0.0000009	0.0000001	-0.000001	0.0000001
27	-0.0000015	0.000018	0.0000001	-0.0000001	-0.000002	0.0000001
28	0.0000008	0.000006	0.0000004	0.0	-0.000001	-0.0000001
29	0.0000008	-0.000003	0.0	-0.0000001	-0.000002	0.0
30	-0.0000003	-0.000003	-0.0000002	-0.0000001	0.000002	0.0
31	-0.0000004	0.000001	-0.0000001	-0.0000001	0.0	0.0
32	0.0	0.000002	0.0	0.0000002	-0.000001	0.0
33	0.0000006	0.000001	0.0	0.0	0.000001	0.0
34	0.0	0.0	-0.0000001	-0.0000001	0.0	0.0
35	-0.0000002	0.000001	0.0	0.0	0.000002	0.0
36	0.0000001	-0.000001	0.0000001	-0.0000001	0.0	0.0
37	-0.0000001	-0.000001	0.0	-0.0000001	-0.000001	-0.0000001
38	0.0	0.0	-0.0000001	0.0000001	0.0	0.0
39	0.0	-0.000001	0.0	0.0000001	-0.000002	0.0
SUMS	23.7546842	-1.146955	2.3632051	22.8176189	4.347607	3.3795744

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1979
MERCURY AND VENUS

DAYS 274 THRU 368   JD 2444147.5 TO 2444242.5   DATES OCT 1 THRU JAN 3

A = 47.50000000   B = -6.76842105

TERM	MERCURY R A	MERCURY DEC	MERCURY DISTANCE	VENUS R A	VENUS DEC	VENUS DISTANCE
	H	DEG	AU	H	DEG	AU
0	31.3516510	-37.100303	2.3150766	34.1570451	-35.048436	3.0580633
1	1.9152345	-5.232892	0.0107909	4.1092901	-6.564085	-0.1791579
2	-0.0020091	1.827916	0.3067556	0.0721792	5.814683	-0.0193334
3	0.7482792	-4.152580	0.0142679	-0.0452996	0.442685	0.0006333
4	0.0845551	0.456841	-0.1078416	-0.0110049	-0.169747	-0.0001141
5	-0.2868954	1.819937	-0.0145141	0.0028318	-0.023057	-0.0000093
6	-0.0563138	0.171921	0.0365946	0.0008815	0.004331	0.0000009
7	0.1273285	-0.765850	0.0093156	-0.0001395	0.001576	-0.0000102
8	0.0342927	-0.212288	-0.0138639	-0.0001062	-0.000034	0.0000145
9	-0.0582338	0.334534	-0.0052788	0.0000339	-0.000147	0.0000122
10	-0.0209210	0.157966	0.0053942	0.0000301	-0.000020	-0.0000084
11	0.0270067	-0.145946	0.0028675	-0.0000101	0.000040	-0.0000050
12	0.0125219	-0.102651	-0.0021218	-0.0000091	0.000006	0.0000025
13	-0.0125615	0.062118	-0.0015195	0.0000029	-0.000022	0.0000011
14	-0.0073581	0.062582	0.0008263	0.0000006	-0.000001	-0.0000008
15	0.0058129	-0.025052	0.0007927	-0.0000014	0.000010	-0.0000002
16	0.0042553	-0.036748	-0.0003122	0.0000003	-0.000002	0.0
17	-0.0026576	0.009083	-0.0004090	-0.0000007	0.000007	-0.0000001
18	-0.0024272	0.021035	0.0001109	0.0000012	0.000005	0.0000003
19	0.0011902	-0.002532	0.0002093	0.0000016	-0.000011	0.0
20	0.0013696	-0.011800	-0.0000345	-0.0000012	-0.000002	-0.0000002
21	-0.0005153	0.000084	-0.0001064	-0.0000012	0.000006	0.0
22	-0.0007657	0.006511	0.0000072	0.0000007	0.0	0.0000002
23	0.0002103	0.000651	0.0000538	0.0000005	-0.000004	0.0
24	0.0004245	-0.003536	0.0000014	-0.0000003	-0.000001	-0.0000001
25	-0.0000776	-0.000731	-0.0000271	0.0	0.000002	0.0
26	-0.0002333	0.001888	-0.0000032	0.0000002	0.000002	-0.0000001
27	0.0000225	0.000601	0.0000135	0.0000001	0.0	0.0
28	0.0001274	-0.000995	0.0000028	-0.0000001	-0.000002	0.0
29	-0.0000017	-0.000436	-0.0000066	0.0	0.0	0.0000001
30	-0.0000691	0.000514	-0.0000020	-0.0000002	-0.000001	0.0
31	-0.0000043	0.000298	0.0000033	-0.0000001	0.0	0.0
32	0.0000372	-0.000259	0.0000014	0.0	0.0	0.0
33	0.0000056	-0.000192	-0.0000016	-0.0000001	0.0	0.0000001
34	-0.0000199	0.000127	-0.0000008	0.0	0.000002	0.0
35	-0.0000046	0.000120	0.0000007	0.0000001	0.0	0.0
36	0.0000105	-0.000061	0.0000004	0.0	0.000001	0.0
37	0.0000033	-0.000076	-0.0000004	0.0	0.0	0.0
38	-0.0000054	0.000027	-0.0000003	0.0000002	0.0	0.0
39	-0.0000023	0.000043	0.0000002	0.0000001	0.000001	0.0
SUMS	33.8632622	-42.860131	2.5570430	38.2857255	-35.542215	2.8600887

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1979
MARS AND JUPITER

DAYS 1 THRU 95 JD 2443874.5 TO 2443969.5 DATES JAN 1 THRU APR 5

A = 47.50000000 B = -1.02105263

TERM	MARS R A (H)	MARS DEC (DEG)	MARS DISTANCE (AU)	JUPITER R A (H)	JUPITER DEC (DEG)	JUPITER DISTANCE (AU)
0	43.1571048	-27.627972	4.7210680	16.6044087	40.601869	9.0660808
1	2.4518742	11.400431	-0.0426075	-0.2882974	1.000446	0.3135167
2	-0.0569303	1.433614	-0.0042219	0.0689906	-0.273029	0.1440533
3	0.0005249	-0.234553	0.0005705	0.0202870	-0.051029	-0.0130240
4	0.0021783	-0.008652	-0.0001421	-0.0031415	0.013330	-0.0025868
5	-0.0001905	0.002745	-0.0000209	-0.0003989	-0.000415	0.0004009
6	-0.0000307	-0.000213	-0.0000003	0.0001386	-0.000544	0.0000287
7	0.0000134	-0.000044	-0.0000100	0.0000035	0.000087	-0.0000106
8	-0.0000299	-0.000107	-0.0000052	0.0000078	-0.000017	-0.0000010
9	-0.0000096	-0.000018	0.0000179	-0.0000002	0.000019	-0.0000186
10	0.0000229	0.000080	0.0000045	-0.0000148	0.000035	0.0000008
11	0.0000054	0.000017	-0.0000082	0.0000011	-0.000010	0.0000124
12	-0.0000087	-0.000028	-0.0000015	0.0000056	-0.000010	-0.0000003
13	-0.0000005	-0.000006	0.0000023	-0.0000004	0.000007	-0.0000039
14	0.0000008	-0.000003	0.0	-0.0000028	0.000010	0.0000005
15	-0.0000006	0.000002	-0.0000005	-0.0000002	-0.000007	0.0000009
16	0.0000007	-0.000002	-0.0000002	0.0000009	0.0	-0.0000001
17	-0.0000005	-0.000002	-0.0000002	0.0000001	-0.000002	-0.0000001
18	0.0000005	0.000010	0.0000004	0.0000007	-0.000001	-0.0000002
19	0.0000014	-0.000001	0.0000003	0.0000002	0.000003	-0.0000001
20	-0.0000007	-0.000008	-0.0000003	-0.0000017	0.000006	0.0000005
21	-0.0000014	0.000001	0.0	-0.0000006	-0.000005	0.0
SUMS	45.5545239	-15.034709	4.6746451	16.4019863	41.290743	9.5084498

DAYS 91 THRU 185 JD 2443964.5 TO 2444059.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.91578947

TERM	MARS R A (H)	MARS DEC (DEG)	MARS DISTANCE (AU)	JUPITER R A (H)	JUPITER DEC (DEG)	JUPITER DISTANCE (AU)
0	52.0085775	20.635131	4.4891719	16.8922726	39.594630	11.1853577
1	2.2768597	12.174992	-0.0841726	0.4384801	-1.543913	0.6598655
2	0.0154222	-1.121826	-0.0100688	0.0736599	-0.310909	-0.0479034
3	0.0038688	-0.175991	-0.0014027	-0.0090777	0.010892	-0.0122642
4	-0.0013184	0.010632	-0.0000667	0.0001246	0.000416	0.0010474
5	-0.0001230	0.000780	-0.0000041	0.0000965	0.000153	-0.0000322
6	-0.0000004	0.000076	0.0000017	-0.0000231	0.000019	-0.0000142
7	-0.0000055	0.000007	-0.0000093	0.0000049	-0.000013	0.0000004
8	-0.0000299	-0.000145	0.0000061	-0.0000033	0.000027	-0.0000149
9	0.0000106	0.000023	0.0000177	-0.0000129	0.000020	0.0000054
10	0.0000230	0.000094	-0.0000046	0.0000032	-0.000020	0.0000161
11	-0.0000047	-0.000021	-0.0000088	0.0000078	-0.000020	-0.0000035
12	-0.0000073	-0.000030	0.0000016	-0.0000011	0.000004	-0.0000067
13	0.0000010	0.000004	0.0000020	-0.0000023	0.000002	0.0000011
14	0.0000021	0.000012	-0.0000003	0.0000014	-0.000006	0.0000013
15	-0.0000002	0.000001	-0.0000002	0.0000005	0.000004	-0.0000001
16	-0.0000010	-0.000002	0.0	-0.0000005	-0.000001	-0.0000001
17	0.0000001	0.000001	0.0000002	0.0	0.000003	0.0000001
18	-0.0000007	-0.000006	0.0	-0.0000010	0.000001	0.0000003
19	0.0000002	-0.000007	-0.0000003	0.0000008	-0.000010	0.0
20	0.0000010	0.000007	0.0000002	0.0000015	-0.000004	-0.0000003
21	-0.0000002	0.000001	0.0000002	-0.0000001	0.000009	0.0000001
SUMS	54.3032749	31.523733	4.3934632	17.3955318	37.751284	11.7860558

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1979
MARS AND JUPITER

DAYS 182 THRU 276 JD 2444055.5 TO 2444150.5 DATES JULY 1 THRU OCT 3

A = 47.50000000 B = -4.83157895

TERM	MARS R A	MARS DEC	MARS DISTANCE	JUPITER R A	JUPITER DEC	JUPITER DISTANCE
	H	DEG	AU	H	DEG	AU
0	12.7466979	43.998655	3.9213586	19.1254793	30.223153	12.4773722
1	2.2279850	-0.423391	-0.2240805	0.6657937	-3.170890	-0.0343041
2	-0.0556431	-1.692048	-0.0254679	-0.0080268	-0.074040	-0.1131323
3	-0.0112226	0.101120	-0.0007930	-0.0056356	0.034336	0.0001090
4	0.0005058	0.018406	0.0001360	0.0000197	0.002178	0.0007381
5	0.0001142	-0.001228	0.0000078	-0.0000370	0.000065	0.0000030
6	-0.0000352	-0.000057	0.0000061	-0.0000043	0.000013	0.0000077
7	-0.0000224	0.000058	-0.0000025	-0.0000008	0.000013	-0.0000040
8	-0.0000085	-0.000059	0.0000177	-0.0000079	0.000026	0.0000073
9	0.0000372	-0.000009	0.0000051	0.0000046	-0.000020	0.0000170
10	0.0000087	0.000018	-0.0000143	0.0000081	-0.000027	-0.0000082
11	-0.0000193	0.000006	-0.0000023	-0.0000043	0.000019	-0.0000096
12	-0.0000039	0.000002	0.0000049	-0.0000037	0.000008	0.0000033
13	0.0000045	0.000005	0.0000010	0.0000007	0.000001	0.0000030
14	0.0000011	-0.000008	-0.0000010	0.0000003	-0.000003	-0.0000004
15	0.0000003	-0.000004	-0.0000005	0.0000011	-0.000008	-0.0000009
16	-0.0000001	0.000001	0.0000001	-0.0000002	0.000001	0.0
17	0.0000003	-0.000003	-0.0000003	0.0000004	-0.000005	-0.0000001
18	-0.0000004	0.000007	0.0	0.0000003	0.000004	-0.0000003
19	-0.0000014	0.000004	0.0000004	-0.0000011	0.000007	0.0000003
20	0.0000006	-0.000008	-0.0000001	-0.0000004	-0.000003	0.0000004
21	0.0000010	-0.000003	-0.0000004	0.0000014	-0.000008	-0.0000003
SUMS	14.9083997	42.001464	3.6711749	19.7775875	27.014820	12.3308011

DAYS 274 THRU 368 JD 2444147.5 TO 2444242.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.76842105

TERM	MARS R A	MARS DEC	MARS DISTANCE	JUPITER R A	JUPITER DEC	JUPITER DISTANCE
	H	DEG	AU	H	DEG	AU
0	19.8934072	28.390727	2.6942564	21.1527985	19.945175	10.9599861
1	1.3765874	-5.903638	-0.3991440	0.3214257	-1.689747	-0.6838571
2	-0.1724591	0.530085	-0.0113214	-0.0847241	0.494704	-0.0279231
3	-0.0184445	0.264172	0.0044201	-0.0073458	0.053191	0.0159100
4	-0.0032835	0.012032	0.0006775	0.0002571	-0.003071	0.0012018
5	-0.0004408	0.000909	0.0000848	0.0001407	-0.001120	-0.0000167
6	0.0000250	-0.000237	0.0000110	0.0000306	-0.000177	-0.0000092
7	0.0000102	-0.000162	0.0000072	0.0000012	-0.000007	0.0000007
8	0.0000517	-0.000252	0.0000073	0.0000095	-0.000045	0.0000088
9	0.0000265	-0.000076	-0.0000178	0.0000078	-0.000029	-0.0000161
10	-0.0000368	0.000148	-0.0000069	-0.0000085	0.000038	-0.0000097
11	-0.0000161	0.000067	0.0000088	-0.0000038	0.000021	0.0000092
12	0.0000108	-0.000042	0.0000028	0.0000025	-0.000007	0.0000042
13	0.0000050	-0.000021	-0.0000026	0.0000015	-0.000004	-0.0000028
14	-0.0000040	0.000019	-0.0000005	-0.0000019	0.000008	-0.0000009
15	-0.0000016	0.000001	0.0000007	-0.0000009	0.000002	0.0000010
16	0.0000015	-0.000004	0.0	0.0000005	-0.000007	0.0
17	0.0000001	-0.000005	0.0	-0.0000003	-0.000001	0.0000001
18	0.0000017	-0.000009	0.0	0.0000010	-0.000008	0.0
19	0.0000005	0.000003	-0.0000004	0.0000008	-0.000003	-0.0000004
20	-0.0000020	0.000014	0.0	-0.0000011	0.000009	-0.0000001
21	-0.0000008	-0.000003	0.0000003	-0.0000009	0.000001	0.0000003
SUMS	21.0754384	23.293728	2.2889833	21.3825901	18.798923	10.2652861

DAYS 1 THRU 95 JD 2443874.5 TO 2443969.5 DATES JAN 1 THRU APR 5

A = 47.50000000 B = -1.02105263

TERM	SATURN R A H	SATURN DEC DEG	SATURN DISTANCE AU	URANUS R A H	URANUS DEC DEG	URANUS DISTANCE AU
0	21.7916830	18.358076	17.0488692	30.4186314	-35.082243	37.0866301
1	-0.1912013	1.268245	-0.1611983	0.0206603	-0.075189	-0.7363390
2	-0.0184110	0.067124	0.1603472	-0.0328686	0.129309	0.0207288
3	0.0108227	-0.070115	0.0057646	0.0000363	-0.000992	0.0220497
4	0.0005507	-0.001696	-0.0030148	0.0005217	-0.001712	-0.0001318
5	-0.0002123	0.001494	-0.0000829	0.0000145	-0.000048	-0.0002174
6	-0.0000103	0.000014	0.0000499	-0.0000036	0.000008	0.0000086
7	0.0000040	-0.000032	0.0000030	-0.0000008	0.000003	0.0000003
8	0.0000058	-0.000028	0.0000076	-0.0000003	0.000005	0.0000146
9	0.0000053	-0.000015	-0.0000154	0.0000040	-0.000013	0.0000047
10	-0.0000052	0.000025	-0.0000105	0.0000019	-0.000009	-0.0000166
11	-0.0000026	0.000012	0.0000095	-0.0000017	-0.000002	-0.0000039
12	0.0000014	-0.000006	0.0000048	-0.0000015	0.000007	0.0000079
13	0.0000012	-0.000005	-0.0000032	0.0000004	-0.000003	0.0000005
14	-0.0000017	0.000008	-0.0000009	-0.0000009	0.0	-0.0000027
15	-0.0000007	0.0	0.0000009	-0.0000005	0.000010	0.0000004
16	0.0000006	-0.000006	0.0000001	0.0000008	0.000002	0.0000005
17	0.0000002	-0.000001	-0.0000001	-0.0000001	0.000004	-0.0000002
18	0.0000012	-0.000006	-0.0000001	0.0000010	-0.000001	0.0000006
19	0.0000006	0.0	-0.0000004	0.0000008	-0.000011	-0.0000006
20	-0.0000014	0.000008	0.0000003	-0.0000016	0.0	0.0000014
21	-0.0000003	0.000002	0.0000004	-0.0000010	0.000009	0.0000001
SUMS	21.5932299	19.623098	17.0507309	30.4069925	-35.030866	36.3927360

DAYS 91 THRU 185 JD 2443964.5 TO 2444059.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.91578947

TERM	SATURN R A H	SATURN DEC DEG	SATURN DISTANCE AU	URANUS R A H	URANUS DEC DEG	URANUS DISTANCE AU
0	21.3966091	20.683318	18.2956459	30.1812210	-34.122060	35.6905889
1	0.0404583	-0.352692	0.7180713	-0.1173022	0.470309	0.1021309
2	0.0579524	-0.349404	0.0288757	0.0049585	-0.019479	0.1566285
3	-0.0008038	0.008731	-0.0196875	0.0049263	-0.020443	-0.0037106
4	-0.0008598	0.004128	0.0003517	-0.0001513	0.000320	-0.0023453
5	0.0001021	-0.000586	0.0001536	-0.0000595	0.000272	0.0000837
6	0.0000007	0.000038	-0.0000292	0.0000047	-0.000005	0.0000166
7	-0.0000011	0.000005	0.0000013	0.0000005	-0.000004	0.0000016
8	0.0000014	-0.000002	-0.0000136	0.0000020	-0.000004	-0.0000001
9	-0.0000071	0.000031	-0.0000056	0.0000003	-0.000006	-0.0000184
10	-0.0000022	0.000005	0.0000166	-0.0000040	0.000017	0.0000008
11	0.0000046	-0.000020	0.0000035	-0.0000001	0.000012	0.0000126
12	0.0000015	-0.000006	-0.0000072	0.0000027	-0.000011	-0.0000008
13	-0.0000014	0.000007	-0.0000011	0.0000001	-0.000002	-0.0000032
14	0.0000010	-0.000005	0.0000015	0.0000007	-0.000005	0.0000001
15	0.0000002	0.000001	0.0000001	-0.0000004	-0.000001	0.0000002
16	-0.0000004	0.000004	0.0000001	-0.0000007	0.000003	0.0000006
17	-0.0000003	-0.000002	-0.0000001	0.0	-0.000001	-0.0000010
18	-0.0000013	0.000005	0.0000003	-0.0000015	0.000003	0.0000007
19	-0.0000001	-0.000005	0.0000002	0.0000003	0.000008	-0.0000011
20	0.0000014	-0.000009	-0.0000002	0.0000013	-0.000008	0.0000003
21	-0.0000003	0.000004	-0.0000002	-0.0000004	-0.000008	-0.0000013
SUMS	21.4934549	19.993546	19.0233771	30.0736383	-33.691093	35.9433837

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1979
SATURN AND URANUS

DAYS 182 THRU 276 JD 2444055.5 TO 2444150.5 DATES JULY 1 THRU OCT 3

A = 47.50000000 B = -4.83157895

TERM	SATURN R A H	SATURN DEC DEG	SATURN DISTANCE AU	URANUS R A H	URANUS DEC DEG	URANUS DISTANCE AU
0	22.1908285	15.541971	20.3903975	30.0287546	-33.559351	37.5585670
1	0.3402604	-2.124985	0.2589038	0.0569869	-0.258038	0.7381471
2	0.0144457	-0.081690	-0.1243321	0.0302785	-0.125228	-0.0171841
3	-0.0047880	0.030071	-0.0054124	-0.0009053	0.005242	-0.0196636
4	-0.0000099	0.000516	0.0011465	-0.0003458	0.001693	0.0003840
5	-0.0000028	0.000019	0.0000007	0.0000230	-0.000124	0.0001176
6	-0.0000045	0.000014	0.0000026	-0.0000002	-0.000013	-0.0000160
7	0.0000004	0.000001	-0.0000032	0.0000001	-0.000002	-0.0000017
8	-0.0000045	0.000022	0.0000009	-0.0000004	-0.000008	-0.0000123
9	-0.0000002	0.000001	0.0000193	-0.0000042	0.000014	0.0000095
10	0.0000055	-0.000024	-0.0000017	0.0000011	-0.000002	0.0000146
11	-0.0000013	0.000009	-0.0000115	0.0000012	-0.000011	-0.0000066
12	-0.0000025	0.000012	0.0000007	-0.0000010	0.000008	-0.0000063
13	0.0	0.000001	0.0000035	-0.0000009	0.000004	0.0000022
14	0.0000001	0.000001	0.0000001	-0.0000003	0.000008	0.0000018
15	0.0000012	-0.000006	-0.0000008	0.0000012	-0.000002	0.0
16	0.0000001	-0.000001	-0.0000001	0.0000002	-0.000003	-0.0000004
17	0.0000001	-0.000004	0.0	0.0000002	-0.000001	0.0000006
18	0.0000007	-0.000002	-0.0000004	0.0000005	-0.000005	0.0000002
19	-0.0000011	0.000010	0.0000003	-0.0000016	0.000003	-0.0000009
20	-0.0000007	0.000005	0.0000004	-0.0000003	0.000010	0.0000003
21	0.0000015	-0.000006	-0.0000001	0.0000012	-0.000006	0.0000002
SUMS	22.5407287	13.365935	20.5207140	30.1147887	-33.935812	38.2603532

DAYS 274 THRU 368 JD 2444147.5 TO 2444242.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.76842105

TERM	SATURN R A H	SATURN DEC DEG	SATURN DISTANCE AU	URANUS R A H	URANUS DEC DEG	URANUS DISTANCE AU
0	23.3831509	8.329775	19.5857431	30.5518764	-35.695694	39.1070877
1	0.2306670	-1.303440	-0.6333113	0.1883731	-0.731287	-0.0436536
2	-0.0429617	0.295835	-0.0708072	-0.0011396	0.017969	-0.1500870
3	-0.0046993	0.029646	0.0153903	-0.0037787	0.014371	0.0005752
4	0.0002082	-0.001937	0.0013702	-0.0000343	-0.000357	0.0019365
5	0.0000530	-0.000406	-0.0000379	0.0000156	-0.000066	0.0000181
6	0.0000096	-0.000052	-0.0000035	0.0000013	0.000011	0.0000033
7	-0.0000008	0.0	0.0000008	-0.0000004	-0.000001	-0.0000011
8	0.0000040	-0.000024	0.0000120	-0.0000004	0.000007	0.0000143
9	0.0000058	-0.000028	-0.0000123	0.0000038	-0.000018	0.0000057
10	-0.0000034	0.000014	-0.0000134	0.0000016	-0.000009	-0.0000155
11	-0.0000025	0.000012	0.0000070	-0.0000012	0.0	-0.0000050
12	0.0000005	-0.000004	0.0000055	-0.0000017	0.000005	0.0000066
13	0.0000010	-0.000007	-0.0000022	0.0000010	-0.000002	0.0000013
14	-0.0000014	0.000007	-0.0000015	-0.0000008	0.000001	-0.0000016
15	-0.0000011	0.000003	0.0000007	-0.0000008	0.000006	-0.0000007
16	0.0000004	-0.000005	0.0000001	0.0000006	0.0	0.0000005
17	-0.0000001	-0.000002	-0.0000001	-0.0000001	-0.000002	-0.0000004
18	0.0000010	-0.000006	0.0000001	0.0000013	-0.000003	0.0000001
19	0.0000011	-0.000007	-0.0000003	0.0000008	-0.000009	0.0
20	-0.0000011	0.000009	0.0	-0.0000012	-0.000001	-0.0000014
21	-0.0000006	0.000006	0.0000004	-0.0000007	0.000008	0.0000010
SUMS	23.5664305	7.349389	18.8983405	30.7353156	-36.395071	38.9158840

DAYS 1 THRU 95 JD 2443874.5 TO 2443969.5 DATES JAN 1 THRU APR 5

A = 47.50000000 B = -1.02105263

	NEPTUNE R A	NEPTUNE DEC	NEPTUNE DISTANCE	PLUTO R A *	PLUTO DEC *	PLUTO DISTANCE
TERM	H	DEG	AU	H	DEG	AU
0	34.5514179	-43.308972	61.1564133	27.14006294	17.8684518	59.5477953
1	0.0590532	-0.035956	-0.6973045	-0.02826496	0.5431041	-0.5750656
2	-0.0193485	0.024525	-0.0587153	-0.01674724	0.0422377	0.0979665
3	-0.0012576	-0.000343	0.0202194	0.00138529	-0.0206764	0.0170556
4	0.0002623	-0.000248	0.0008794	0.00028940	-0.0008798	-0.0015408
5	0.0000129	0.000017	-0.0001872	-0.00001379	0.0002412	-0.0001748
6	-0.0000014	0.000003	0.0000014	-0.00000268	0.0000057	0.0000236
7	0.0	-0.000004	0.0000006	-0.00000017	-0.0000016	0.0000017
8	-0.0000011	0.000003	0.0000112	0.00000040	-0.0000095	0.0000136
9	0.0000015	-0.000007	0.0000145	0.00000236	-0.0000085	-0.0000046
10	0.0000024	-0.000003	-0.0000120	-0.00000036	0.0000105	-0.0000162
11	-0.0000003	-0.000005	-0.0000097	-0.00000148	0.0000057	0.0000025
12	-0.0000017	-0.000002	0.0000045	0.00000009	-0.0000044	0.0000069
13	0.0000003	0.000001	0.0000023	0.00000044	-0.0000017	-0.0000010
14	-0.0000008	-0.000003	-0.0000018	-0.00000006	0.0000013	-0.0000016
15	-0.0000005	0.000006	0.0	-0.00000008	0.0000006	0.0000004
16	0.0000006	-0.000002	0.0000003	0.00000003	-0.0000003	0.0000003
17	0.0000001	0.000003	0.0000002	0.00000001	0.0	0.0000002
18	0.0000009	0.000003	0.0	0.00000003	0.0	-0.0000001
19	0.0000009	-0.000006	-0.0000009	-0.00000001	-0.0000001	-0.0000005
20	-0.0000015	-0.000003	0.0000007	-0.00000005	0.0000002	0.0
21	-0.0000011	0.000008	0.0000002	0.00000001	-0.0000003	0.0000003
SUMS	34.5901385	-43.320985	60.4213166	27.09671012	18.4324762	59.0860617

DAYS 91 THRU 185 JD 2443964.5 TO 2444059.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.91578947

	NEPTUNE R A	NEPTUNE DEC	NEPTUNE DISTANCE	PLUTO R A *	PLUTO DEC *	PLUTO DISTANCE
TERM	H	DEG	AU	H	DEG	AU
0	34.5084236	-43.179266	58.9867160	26.93976849	19.2760044	59.2491258
1	-0.0738240	0.089386	-0.2948016	-0.05681649	0.0629741	0.4296537
2	-0.0087605	0.004178	0.1446556	0.01049649	-0.1387542	0.1148607
3	0.0028341	-0.003090	0.0082564	0.00216184	-0.0034012	-0.0136934
4	0.0001361	-0.000149	-0.0021043	-0.00019987	0.0022010	-0.0014497
5	-0.0000305	0.000013	-0.0000495	-0.00001568	-0.0000488	0.0001598
6	-0.0000012	0.000004	0.0000184	0.00000362	-0.0000198	-0.0000019
7	-0.0000003	0.000004	0.0000025	0.00000010	-0.0000004	0.0000004
8	0.0000006	0.000002	0.0000073	0.00000154	-0.0000038	-0.0000074
9	0.0000023	0.000002	-0.0000155	-0.00000107	0.0000137	-0.0000155
10	-0.0000021	0.000004	-0.0000082	-0.00000191	0.0000044	0.0000089
11	-0.0000013	0.000009	0.0000113	0.00000073	-0.0000090	0.0000103
12	0.0000015	-0.000003	0.0000031	0.00000082	-0.0000017	-0.0000038
13	0.0000004	0.0	-0.0000033	-0.00000022	0.0000029	-0.0000031
14	0.0000008	-0.000001	0.0000001	-0.00000014	0.0000001	0.0000009
15	-0.0000003	-0.000004	-0.0000005	0.00000003	-0.0000002	0.0000003
16	-0.0000009	0.000002	-0.0000001	0.00000003	-0.0000001	-0.0000001
17	0.0000001	0.0	0.0000003	-0.00000001	0.0000001	-0.0000001
18	-0.0000012	0.000001	-0.0000005	-0.00000004	0.0000001	0.0000001
19	0.0000003	0.000009	0.0000007	0.0	-0.0000005	0.0000003
20	0.0000017	-0.000002	0.0000003	0.00000001	0.0000001	-0.0000001
21	-0.0000001	-0.000010	-0.0000005	-0.00000002	0.0000003	-0.0000003
SUMS	34.4287791	-43.088911	58.8426880	26.89539825	19.1989615	59.7786458

* ASTROMETRIC POSITION, EQUATOR AND EQUINOX 1950.0

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1979
NEPTUNE AND PLUTO

DAYS 182 THRU 276 JD 2444055.5 TO 2444150.5 DATES JULY 1 THRU OCT 3

A = 47.50000000 B = -4.83157895

TERM	NEPTUNE R A H	NEPTUNE DEC DEG	NEPTUNE DISTANCE AU	PLUTO R A * H	PLUTO DEC * DEG	PLUTO DISTANCE AU
0	34.2857655	-42.985783	59.8439276	26.94576846	17.8360251	61.4197164
1	-0.0205396	-0.012522	0.6784921	0.06334091	-0.7352879	0.5488808
2	0.0194761	-0.026600	0.0624755	0.01508256	-0.0370157	-0.0856260
3	0.0010264	-0.000552	-0.0192493	-0.00123612	0.0162334	-0.0151241
4	-0.0002840	0.000488	-0.0007986	-0.00016517	0.0002839	0.0010667
5	-0.0000006	0.000009	0.0001543	0.00001052	-0.0000854	0.0000812
6	0.0000028	-0.000014	-0.0000110	-0.00000119	0.0000111	-0.0000087
7	0.0000001	-0.000004	-0.0000004	0.00000011	-0.0000002	-0.0000019
8	0.0000013	-0.000006	-0.0000159	-0.00000144	0.0000110	-0.0000075
9	-0.0000037	0.000001	-0.0000003	-0.00000128	-0.0000010	0.0000164
10	-0.0000004	0.000002	0.0000179	0.00000173	-0.0000124	0.0000080
11	0.0000007	-0.000007	-0.0000020	0.00000074	0.0000013	-0.0000103
12	-0.0000004	0.000006	-0.0000076	-0.00000073	0.0000052	-0.0000032
13	-0.0000005	-0.000001	0.0000005	-0.00000026	-0.0000006	0.0000032
14	-0.0000009	0.000007	0.0000008	0.00000017	-0.0000013	0.0000013
15	0.0000013	0.000005	-0.0000001	0.00000009	-0.0000001	-0.0000006
16	0.0000001	-0.000002	0.0000003	-0.00000004	0.0000003	-0.0000003
17	0.0000001	0.0	0.0000005	0.00000001	-0.0000001	0.0
18	0.0000006	-0.000008	-0.0000007	0.00000001	0.0	-0.0000003
19	-0.0000018	-0.000001	-0.0000006	-0.00000005	0.0000003	0.0000001
20	-0.0000005	0.000011	-0.0000003	0.0	-0.0000001	0.0000005
21	0.0000011	0.000005	0.0	0.00000005	-0.0000003	0.0
SUMS	34.2854437	-43.024966	60.5649827	27.02279908	17.0801665	61.8689917

DAYS 274 THRU 368 JD 2444147.5 TO 2444242.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.76842105

TERM	NEPTUNE R A H	NEPTUNE DEC DEG	NEPTUNE DISTANCE AU	PLUTO R A * H	PLUTO DEC * DEG	PLUTO DISTANCE AU
0	34.4779096	-43.325156	62.0641191	27.29145078	15.5146849	61.7092348
1	0.1109937	-0.140323	0.3065564	0.09686694	-0.3344738	-0.4289481
2	0.0084929	0.001121	-0.1409492	-0.00812157	0.1262032	-0.1223180
3	-0.0024763	0.003699	-0.0090594	-0.00221459	0.0075904	0.0108554
4	-0.0001089	-0.000122	0.0019129	0.00006653	-0.0015021	0.0018422
5	0.0000155	-0.000043	0.0000741	0.00001611	-0.0000980	-0.0000524
6	-0.0000003	0.000011	-0.0000002	0.00000078	-0.0000044	-0.0000016
7	0.0	-0.000006	-0.0000042	-0.00000033	0.0000022	0.0
8	-0.0000010	0.000005	0.0000108	0.00000017	-0.0000078	0.0000144
9	0.0000020	-0.000005	0.0000141	0.00000226	-0.0000094	-0.0000037
10	0.0000020	-0.000004	-0.0000119	-0.00000024	0.0000084	-0.0000164
11	0.0000001	-0.000009	-0.0000082	-0.00000139	0.0000059	0.0000019
12	-0.0000018	-0.000001	0.0000041	0.00000007	-0.0000034	0.0000067
13	0.0000003	-0.000002	0.0000025	0.00000043	-0.0000021	-0.0000006
14	-0.0000009	-0.000002	-0.0000009	-0.00000002	0.0000012	-0.0000018
15	-0.0000009	0.000009	0.0000002	-0.00000007	0.0000004	0.0000005
16	0.0000002	0.000003	0.0000005	0.00000002	-0.0000002	0.0000003
17	0.0	0.000004	-0.0000001	0.0	-0.0000001	-0.0000001
18	0.0000012	0.000003	-0.0000006	0.00000001	-0.0000001	0.0000001
19	0.0000008	-0.000008	-0.0000016	0.0	-0.0000002	-0.0000003
20	-0.0000014	-0.000008	-0.0000011	-0.00000003	0.0000002	-0.0000003
21	-0.0000007	0.000006	0.0000009	-0.00000001	0.0000003	0.0000003
SUMS	34.5948261	-43.460828	62.2226582	27.37806585	15.3123955	61.1706133

* ASTROMETRIC POSITION, EQUATOR AND EQUINOX 1950.0

CHEBYSHEV APPRCXIMATION CF SIDEREAL TIME FOR YEAR 1979

DAYS 1 THRU 365 JD 2443874.5 TC 2444239.5 DATES JAN 1 THRU DEC 31

A = 182.50000000 B = -1.00547945

TERM	APP S T H	EQ CF EQ S	NUT LON ''	NUT CBL ''
0	37.32420358	-0.6618	-10.8201	-17.7370
1	11.99198462	-0.2094	-3.4235	0.4169
2	0.00000483	0.0174	0.2840	-0.2481
3	0.00000053	0.0019	0.0315	-0.0C57
4	0.00000502	0.0181	0.2955	-0.3356
5	0.00001361	0.0490	0.8013	0.1223
6	-0.00000360	-0.0130	-0.2119	0.2783
7	-0.00000705	-0.0254	-0.4152	-0.C642
8	0.00000044	0.0016	0.C261	-0.C319
9	-0.00000011	-0.0004	-0.C063	-0.0020
SUMS	49.31620187	-0.8220	-13.4386	-17.6070

CHEBYSHEV APPRCXIMATION OF SOLAR COORDINATES FOR YEAR 1979

DAYS 1 THRU 365 JD 2443874.5 TO 2444239.5 DATES JAN 1 THRU DEC 31

A = 182.50000000 B = -1.00547945

TERM	R A H	DEC DEG	DISTANCE AU	S D '	EPHEM TR H
0	61.3448724	-13.380097	1.99008225	32.20372	24.0225654
1	11.8527402	-2.340966	0.00044802	-0.0C726	-0.1388330
2	0.0257325	-22.536594	-0.016292C0	0.26232	0.0283864
3	0.0706431	2.654884	-0.00052061	C.00832	0.0707569
4	0.0395956	6.600442	0.00495640	-0.07797	0.0410919
5	0.1051524	-0.359591	0.00006146	-C.00083	0.1043912
6	-0.0297548	-0.493380	-0.00040669	0.0053C	-0.0311217
7	-0.0437322	0.064318	-0.00000686	0.00005	-0.0434658
8	0.0069594	0.073749	0.00000329	0.00024	0.0072458
9	0.0073847	-0.037586	-0.00000825	0.00013	0.0073116
10	-0.0019809	-0.035912	0.C0000189	-0.C0005	-0.0020556
11	-0.0017665	0.011594	-0.C0000773	0.00013	-0.0017297
12	0.0009522	0.008687	0.COCC0014	0.C0001	0.0009934
13	0.0006890	-0.002960	-0.00000463	0.00008	0.0006696
14	-0.0003785	-0.001763	0.C0C00059	-0.C0002	-0.0003924
15	-0.0001951	0.001119	0.00000125	C.0	-0.0001884
16	0.0000766	0.000514	0.00000067	-0.00001	0.0000814
17	0.0000481	-0.000307	0.000C0674	-0.00009	0.0000485
18	-0.0000420	-0.000148	0.C0000006	-0.00002	-0.C000433
19	-0.0000105	0.000121	0.00000782	-0.00012	-0.0000069
20	0.0000431	0.000047	-0.000C0036	0.0	0.0000431
21	0.0000060	-0.000127	0.C0000099	-0.C0001	0.0000056
SUMS	73.3770348	-29.773956	1.97832444	32.39392	24.0657540

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1979
MERCURY AND VENUS

DAYS 1 THRU 365 JD 2443874.5 TO 2444239.5 DATES JAN 1 THRU DEC 31

A = 182.50000000 B = -1.00547945

TERM	MERCURY R A H	MERCURY DEC DEG	MERCURY DISTANCE AU	VENUS R A H	VENUS DEC DEG	VENUS DISTANCE AU
0	60.7164580	-15.860172	2.2052043	59.8303421	-18.331440	2.5623673
1	12.0203143	-1.907649	-0.0246621	14.7577503	-1.301973	0.4271790
2	-0.7222327	-20.575351	0.1632608	0.2498791	-17.880668	-0.3542841
3	-0.1459661	3.169640	-0.0158124	-0.0141930	-2.128017	-0.0256888
4	-0.3844047	6.462962	0.0434383	0.0630440	11.889996	0.0187842
5	0.3921675	0.492801	0.1404830	0.0404407	1.623855	0.0020154
6	-0.1254820	-1.633556	0.0113015	0.0348256	-2.119599	-0.0018215
7	0.2273619	-4.233418	0.1543527	-0.0979381	-0.137305	-0.0009592
8	0.8921450	0.494072	-0.0789673	-0.0245940	0.160451	0.0004336
9	-0.2088037	-0.769596	-0.2174807	0.0325371	0.046188	0.0000725
10	-0.5973241	0.355016	0.0317680	0.0080981	-0.088322	-0.0000266
11	0.0862888	4.169756	0.0752897	-0.0066849	-0.041818	-0.0000276
12	0.0888636	-0.528069	-0.0194359	-0.0016617	0.046673	0.0000039
13	-0.0989202	-2.364020	0.0008439	0.0021932	0.020464	-0.0000064
14	-0.0464498	1.157922	0.0085155	0.0011561	-0.014228	0.0000020
15	-0.0187648	0.488866	0.0148056	-0.0011920	-0.005958	-0.0000046
16	0.1445635	-0.903634	0.0171705	-0.0007740	0.003725	0.0000018
17	0.1364592	-0.362151	-0.0166439	0.0004792	0.001977	0.0000027
18	-0.0776552	-0.258265	-0.0157677	0.0002640	-0.001303	0.0000015
19	-0.0690461	0.380561	-0.0039169	-0.0001352	-0.001042	0.0000081
20	-0.0077905	0.584134	-0.0040750	-0.0000958	0.000539	-0.0000005
21	-0.0251561	-0.162599	0.0109181	0.0000501	0.000515	0.0000056
22	0.0177606	-0.050154	0.0072839	0.0000833	-0.000204	-0.0000021
23	0.0069283	0.106152	-0.0075685	-0.0000324	-0.000212	-0.0000041
24	-0.0260449	-0.171714	0.0009029	-0.0000108	0.000059	-0.0000008
25	0.0289586	0.000331	0.0061650	0.0000030	0.000056	-0.0000085
26	0.0385588	-0.002610	-0.0014305	-0.0000169	-0.000004	0.0000023
27	-0.0102263	-0.192132	-0.0038762	0.0000087	0.000032	0.0000020
28	-0.0190445	0.053850	-0.0021885	-0.0000216	-0.000005	0.0000013
29	-0.0109102	0.166841	0.0002440	0.0000063	0.000001	0.0000093
30	-0.0022403	0.001295	0.0014535	0.0000283	-0.000016	-0.0000028
31	0.0056902	-0.004305	0.0004884	-0.0000102	-0.000110	-0.0000050
32	-0.0029384	0.012011	0.0007576	0.0000045	0.000037	-0.0000003
33	-0.0013030	-0.026954	0.0004359	-0.0000022	0.000134	-0.0000064
34	0.0096874	-0.016251	-0.0008158	-0.0000275	-0.000049	0.0000032
35	0.0039898	-0.026992	-0.0000412	0.0000087	-0.000047	0.0000117
36	-0.0021604	-0.019289	0.0004179	0.0000283	0.000031	-0.0000037
37	-0.0010814	0.023799	-0.0006315	-0.0000095	-0.000030	-0.0000101
38	-0.0036638	0.010263	-0.0006426	-0.0000180	-0.000002	0.0000027
39	-0.0027172	0.001052	0.0002697	0.0000074	0.000052	0.0000058
40	0.0011910	0.025185	0.0004967	0.0000082	-0.000003	-0.0000014
41	0.0002463	0.004380	0.0001236	-0.0000020	-0.000041	-0.0000026
42	0.0002314	-0.019380	0.0000045	-0.0000039	0.000006	0.0000004
43	0.0021662	-0.005551	0.0000640	0.0000009	0.000023	0.0000011
44	0.0011560	-0.004967	-0.0001488	0.0000021	-0.000008	-0.0000003
45	-0.0004433	-0.007080	-0.0001884	-0.0000015	-0.000008	-0.0000003
46	-0.0008446	0.006478	0.0000753	-0.0000001	0.000002	0.0000001
47	-0.0008127	0.005049	0.0000558	-0.0000007	0.000002	0.0000001
48	-0.0001387	-0.000471	-0.0001214	0.0000003	0.000003	0.0000001
49	-0.0001534	0.004872	-0.0000377	0.0000006	-0.000004	-0.0000001
SUMS	72.2084673	-31.929042	2.4821376	74.8738242	-28.257955	2.6280499

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1979
MARS AND JUPITER

DAYS 1 THRU 365 JD 2443874.5 TO 2444239.5 DATES JAN 1 THRU DEC 31

A = 182.50000000 B = -1.00547945

TERM	MARS R A H	MARS DEC DEG	MARS DISTANCE AU	JUPITER R A H	JUPITER DEC DEG	JUPITER DISTANCE AU
0	55.5257706	7.443811	3.8162926	18.7064460	31.297933	10.4301798
1	8.2222229	18.318084	-0.6844430	1.3887292	-6.391390	0.5351174
2	-0.5587902	-13.864197	-0.2376710	0.4224567	-2.095129	-0.7821097
3	-0.2121606	-2.114677	-0.0410842	-0.3348908	1.271405	-0.3235912
4	-0.1294355	3.101906	0.0109828	-0.0351982	0.363814	0.1732416
5	0.0137364	0.172078	0.0096495	0.0291045	-0.007917	0.0094629
6	0.0124625	-0.155396	0.0008957	-0.0189744	0.020066	-0.0046977
7	-0.0120046	-0.009520	0.0001513	0.0049817	-0.023516	0.0052773
8	-0.0034760	0.016765	0.0001544	0.0011874	0.004530	-0.0018821
9	0.0008606	0.011923	0.0000199	-0.0011520	-0.001211	0.0000491
10	0.0006876	-0.003509	0.0000144	0.0006602	-0.001791	0.0001619
11	-0.0000559	-0.002511	0.0000043	-0.0001287	0.001178	-0.0001309
12	-0.0002024	0.000409	0.0000072	-0.0000456	-0.000422	0.0000442
13	0.0000208	0.000377	0.0000013	0.0000510	0.000025	0.0000018
14	0.0000429	-0.000074	0.0000050	-0.0000215	0.000082	-0.0000026
15	0.0000164	-0.000147	0.0000040	0.0000013	-0.000059	0.0000072
16	-0.0000039	-0.000082	0.0000009	0.0000082	0.000002	0.0000035
17	0.0000151	-0.000022	0.0000043	-0.0000016	-0.000004	-0.0000021
18	0.0000143	-0.000068	-0.0000048	0.0000043	-0.000024	0.0000036
19	0.0000102	-0.000050	0.0000015	0.0000043	-0.000010	-0.0000064
20	0.0000116	-0.000017	-0.0000067	-0.0000011	-0.000009	-0.0000011
21	-0.0000071	-0.000015	-0.0000034	0.0000040	-0.000004	-0.0000049
SUMS	62.8597357	12.915068	2.8749760	20.1632249	24.437549	10.0411216

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1979
SATURN AND URANUS

DAYS 1 THRU 365 JD 2443874.5 TO 2444239.5 DATES JAN 1 THRU DEC 31

A = 182.50000000 B = -1.00547945

TERM	SATURN R A H	SATURN DEC DEG	SATURN DISTANCE AU	URANUS R A H	URANUS DEC DEG	URANUS DISTANCE AU
0	22.4058048	14.422383	18.5814802	30.3878798	-34.989085	37.7633104
1	0.4896527	-3.049467	0.6582290	0.0715432	-0.305541	0.4893521
2	0.3432852	-2.076998	-0.4061595	0.1518985	-0.612133	0.6249978
3	-0.1033403	0.743531	-0.5621481	0.0863187	-0.328031	-0.5033486
4	-0.0809567	0.474734	0.1261051	-0.0486070	0.207157	-0.1806610
5	0.0241771	-0.138726	0.0601640	-0.0112248	0.049067	0.0810852
6	-0.0011789	0.014995	-0.0163555	0.0064349	-0.028636	0.0128302
7	-0.0032874	0.011253	0.0028992	-0.0000452	-0.003100	-0.0068838
8	0.0019647	-0.011776	0.0010125	-0.0007435	0.003701	0.0004581
9	-0.0000982	0.002377	-0.0010639	0.0001825	-0.000098	0.0005323
10	-0.0002440	0.000754	0.0001909	0.0000755	-0.000522	-0.0001940
11	0.0001274	-0.000833	0.0000626	-0.0000403	0.000107	-0.0000451
12	-0.0000137	0.000267	-0.0000536	-0.0000045	0.000069	0.0000328
13	-0.0000203	0.000054	0.0000176	0.0000058	-0.000026	-0.0000027
14	0.0000114	-0.000081	0.0000092	-0.0000009	0.000002	0.0000027
15	-0.0000025	0.000035	-0.0000029	-0.0000017	0.000013	-0.0000005
16	0.0	-0.000006	0.0000083	-0.0000004	0.000005	0.0000060
17	0.0000020	-0.000012	-0.0000014	0.0000005	-0.000001	0.0000024
18	0.0000003	-0.000001	0.0000037	-0.0000006	-0.000002	0.0000031
19	0.0000037	-0.000021	-0.0000033	0.0000018	-0.000010	0.0000039
20	-0.0000004	-0.000001	-0.0000027	0.0000010	0.000003	-0.0000024
21	0.0000020	-0.000009	-0.0000021	0.0000009	-0.000006	0.0000034
SUMS	23.0758889	10.392452	18.4443893	30.6436742	-36.007067	38.2814823

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1979
NEPTUNE AND PLUTO

DAYS 1 THRU 365 JD 2443874.5 TO 2444239.5 DATES JAN 1 THRU DEC 31

A = 182.50000000 B = -1.00547945

TERM	NEPTUNE R A	NEPTUNE DEC	NEPTUNE DISTANCE	PLUTO R A *	PLUTC DEC *	PLUTO DISTANCE
	H	CEG	AU	H	DEG	AU
0	34.4823233	-43.256577	61.0914517	27.14860611	17.1311119	60.5817966
1	0.0032295	-0.030780	0.2039818	0.05569550	-0.6791536	0.5039932
2	0.0452844	-0.092987	0.9097240	0.11149649	-0.7793116	0.1421360
3	0.0837663	-0.081219	-0.2334107	0.02073848	0.2685544	-0.6221441
4	-0.0147092	0.030504	-0.2765672	-0.03396975	0.2273592	-0.0358806
5	-0.0132612	0.015054	0.0379528	-0.00169650	-0.04989C3	0.0912618
6	0.0019551	-0.001709	0.0252794	0.00316956	-0.C150656	-0.0008424
7	0.0009918	-0.002079	-0.0032282	-0.00041924	0.C05946C	-0.0043685
8	-0.0002394	-0.000241	-0.0010103	-0.00011923	-0.0009355	0.0009871
9	-0.0000626	0.000312	0.0002632	0.00010299	-0.C0C5564	-0.0001262
1C	0.0000319	0.000050	0.0000148	-0.00000807	0.C0C2782	-0.0001333
11	0.0000037	-0.000044	-0.0000354	-0.00001149	0.0000186	0.0000363
12	-0.0000049	-0.000003	0.0000007	0.00000267	-0.C0C0327	0.0000100
13	-0.0000001	0.000006	-0.0000005	-0.00000C19	0.C0C0101	-0.0000045
14	-0.0000004	0.000008	0.0000024	-0.00000C57	-0.C0C0007	0.0000075
15	-0.0000009	0.000005	-0.0000004	-0.0000CC06	-0.00C0007	0.0000003
16	-0.0000008	0.000005	0.0000030	-0.00000C15	-0.C0C0026	0.0000074
17	-0.0000002	0.000002	0.0000049	0.00000C58	-0.C0C0028	0.0000008
18	-0.0000003	0.000001	0.0000013	-0.00000012	-0.00C0013	0.0000033
19	0.0000012	-0.000005	0.0000072	0.00000C97	-0.C0C0C50	0.0000010
20	0.0000011	0.000003	0.0	0.0000CC09	0.00C0012	-0.0000034
21	0.0000004	0.000002	0.0000037	0.00000C52	-0.C0C0C31	0.0000005
SUMS	34.5893087	-43.419692	61.7544382	27.30358859	16.1083177	60.6567388

* ASTRCMETRIC POSITION, EQUATOR AND EQUINOX 1950.0

Section E: STELLAR TABLES

DAYS 1 THRU 365 JD 2443874.5 TO 2444239.5 DATES JAN 1 THRU DEC 31

A = 365.00000000 B = -0.00273973

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
1	1	ALPHA AND	2.1	SHA	358.1754	-0.0007	-0.0114	0.0059	0.0008	358.1682
		ALPHERATZ	A0	DEC	28.9744	-0.0004	0.0049	-0.0024	0.0024	28.9742
2		BETA CAS	2.4	SHA	357.9879	-0.0035	-0.0114	0.0101	0.0014	357.9773
		CAPH	F5	DEC	59.0339	-0.0004	0.0049	-0.0018	0.0046	59.0313
3		GAMMA PEG	2.9	SHA	356.9621	-0.0000	-0.0114	0.0054	0.0006	356.9558
		ALGENIB	B2	DEC	15.0669	-0.0004	0.0049	-0.0023	0.0011	15.0679
4		BETA HYI	2.9	SHA	353.8333	0.0118	-0.0096	0.0239	0.0014	353.8389
			G0	DEC	-77.3725	-0.0006	0.0049	-0.0001	-0.0056	-77.3650
5	2	ALPHA PHE	2.4	SHA	353.6879	0.0029	-0.0110	0.0071	0.0004	353.6850
		ANKAA	K0	DEC	-42.4200	-0.0006	0.0049	-0.0014	-0.0041	-42.4140
6	3	ALPHA CAS	2.3	SHA	350.1738	-0.0030	-0.0124	0.0095	-0.0001	350.1646
		SCHEDAR	K0	DEC	56.4225	-0.0007	0.0049	-0.0013	0.0045	56.4197
7	4	BETA CET	2.2	SHA	349.3663	0.0015	-0.0111	0.0055	-0.0001	349.3623
		DIPHDA	K0	DEC	-18.1017	-0.0008	0.0049	-0.0021	-0.0021	-18.0978
8		GAMMA CAS	2-3	SHA	346.1429	-0.0036	-0.0132	0.0107	-0.0009	346.1337
			B0	DEC	60.6033	-0.0009	0.0048	-0.0009	0.0047	60.6001
9		BETA AND	2.4	SHA	342.8625	-0.0010	-0.0123	0.0064	-0.0010	342.8563
		MIRACH	M0	DEC	35.5094	-0.0010	0.0048	-0.0015	0.0029	35.5079
10		DELTA CAS	2.8	SHA	338.8929	-0.0033	-0.0142	0.0104	-0.0023	338.8849
		RUCHBAH	A5	DEC	60.1267	-0.0012	0.0046	-0.0003	0.0046	60.1232
11	5	ALPHA ERI	0.6	SHA	335.7667	0.0041	-0.0084	0.0094	-0.0027	335.7693
		ACHERNAR	B5	DEC	-57.3433	-0.0013	0.0046	-0.0022	-0.0048	-57.3375
12		BETA ARI	2.7	SHA	331.6308	-0.0001	-0.0122	0.0053	-0.0020	331.6266
		SHERATAN	A5	DEC	20.7058	-0.0015	0.0044	-0.0015	0.0015	20.7050
13		ALPHA HYI	3.0	SHA	330.4729	0.0045	-0.0070	0.0105	-0.0041	330.4780
			F0	DEC	-61.6717	-0.0015	0.0044	-0.0025	-0.0049	-61.6661
14		GAMMA-1 AND	2.3	SHA	329.3492	-0.0012	-0.0135	0.0067	-0.0028	329.3440
		ALMAK	K0	DEC	42.2297	-0.0015	0.0043	-0.0005	0.0033	42.2271
15	6	ALPHA ARI	2.2	SHA	328.5038	-0.0002	-0.0124	0.0053	-0.0023	328.4997
		HAMAL	K2	DEC	23.3636	-0.0016	0.0043	-0.0013	0.0017	23.3625
16		BETA TRI	3.1	SHA	327.9279	-0.0007	-0.0131	0.0060	-0.0027	327.9233
			A5	DEC	34.8886	-0.0016	0.0042	-0.0007	0.0027	34.8865
17		ALPHA UMI	2.1	SHA	327.2754	-0.1351	-0.1875	0.3354	-0.1560	327.2026
		POLARIS	F8	DEC	89.1689	-0.0016	0.0042	0.0019	0.0052	89.1642
18	7	THETA ERI	3.4	SHA	315.6342	0.0020	-0.0085	0.0057	-0.0043	315.6362
		ACAMAR	A2	DEC	-40.3883	-0.0020	0.0036	-0.0036	-0.0033	-40.3852
19	8	ALPHA CET	2.8	SHA	314.7050	0.0006	-0.0116	0.0043	-0.0034	314.7031
		MENKAR	M0	DEC	4.0081	-0.0020	0.0036	-0.0020	-0.0001	4.0079
20		BETA PER	2-3	SHA	313.3008	-0.0006	-0.0144	0.0056	-0.0046	313.2976
		ALGOL	B8	DEC	40.8758	-0.0020	0.0035	0.0003	0.0027	40.8729

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
21	9	ALPHA PER	1.9	SHA	309.2963	-0.0010	-0.0158	0.0062	-0.0058	309.2932
		MIRFAK	F5	DEC	49.7875	-0.0021	0.0032	0.0011	0.0030	49.7840
22		ETA TAU	3.0	SHA	303.4417	0.0002	-0.0131	0.0040	-0.0046	303.4398
		ALCYONE	B5	DEC	24.0411	-0.0023	0.0028	-0.0005	0.0012	24.0390
23		ZETA PER	2.9	SHA	301.7979	-0.0000	-0.0139	0.0042	-0.0050	301.7960
			B1	DEC	31.8222	-0.0023	0.0027	0.0001	0.0016	31.8196
24		EPSILON PER	3.0	SHA	300.8900	-0.0002	-0.0148	0.0046	-0.0057	300.8880
			B1	DEC	39.9506	-0.0023	0.0026	0.0008	0.0020	39.9475
25		GAMMA ERI	3.2	SHA	300.7379	0.0009	-0.0103	0.0036	-0.0045	300.7381
			K5	DEC	-13.5675	-0.0023	0.0026	-0.0031	-0.0012	-13.5673
26	10	ALPHA TAU	1.1	SHA	291.3217	0.0005	-0.0127	0.0029	-0.0051	291.3209
		ALDEBARAN	K5	DEC	16.4681	-0.0025	0.0019	-0.0009	0.0004	16.4661
27		IOTA AUR	2.9	SHA	286.0942	0.0004	-0.0144	0.0028	-0.0061	286.0935
			K2	DEC	33.1342	-0.0025	0.0015	0.0007	0.0010	33.1314
28		BETA ERI	2.9	SHA	283.2958	0.0007	-0.0109	0.0022	-0.0053	283.2963
			A3	DEC	-5.1125	-0.0025	0.0013	-0.0026	-0.0006	-5.1138
29	11	BETA ORI	0.3	SHA	281.6179	0.0007	-0.0106	0.0020	-0.0054	281.6187
		RIGEL	B8	DEC	-8.2250	-0.0025	0.0011	-0.0029	-0.0007	-8.2263
30	12	ALPHA AUR	0.2	SHA	281.2163	0.0005	-0.0163	0.0028	-0.0077	281.2162
		CAPELLA	G0	DEC	45.9781	-0.0025	0.0011	0.0019	0.0012	45.9749
31	13	GAMMA ORI	1.7	SHA	278.9992	0.0007	-0.0119	0.0018	-0.0054	278.9993
		BELLATRIX	B2	DEC	6.3317	-0.0025	0.0009	-0.0017	-0.0002	6.3298
32	14	BETA TAU	1.8	SHA	278.7592	0.0006	-0.0140	0.0020	-0.0062	278.7589
		ELNATH	B8	DEC	28.5908	-0.0025	0.0009	0.0004	0.0005	28.5882
33		BETA LEP	3.0	SHA	278.1638	0.0007	-0.0095	0.0018	-0.0058	278.1655
			G0	DEC	-20.7753	-0.0025	0.0008	-0.0038	-0.0010	-20.7764
34		DELTA ORI	2.5	SHA	277.2667	0.0007	-0.0113	0.0016	-0.0054	277.2671
			B0	DEC	-0.3136	-0.0025	0.0008	-0.0023	-0.0004	-0.3154
35		ALPHA LEP	2.7	SHA	277.0492	0.0007	-0.0098	0.0017	-0.0057	277.0507
			F0	DEC	-17.8364	-0.0025	0.0007	-0.0036	-0.0009	-17.8377
36		IOTA ORI	2.9	SHA	276.3987	0.0007	-0.0108	0.0016	-0.0055	276.3995
			O5	DEC	-5.9228	-0.0025	0.0007	-0.0027	-0.0006	-5.9244
37	15	EPSILON ORI	1.7	SHA	276.2133	0.0007	-0.0112	0.0015	-0.0055	276.2139
		ALNILAM	B0	DEC	-1.2142	-0.0025	0.0007	-0.0023	-0.0004	-1.2160
38		ZETA TAU	3.0	SHA	275.9029	0.0007	-0.0132	0.0016	-0.0059	275.9029
			B3	DEC	21.1308	-0.0025	0.0006	-0.0003	0.0002	21.1284
39		ALPHA COL	2.7	SHA	275.2779	0.0006	-0.0080	0.0018	-0.0066	275.2812
		PHACT	B5	DEC	-34.0847	-0.0025	0.0006	-0.0047	-0.0011	-34.0858
40		ZETA ORI	2.0	SHA	275.0754	0.0007	-0.0112	0.0014	-0.0055	275.0760
		ALNITAK	B0	DEC	-1.9528	-0.0025	0.0006	-0.0024	-0.0004	-1.9546
41		KAPPA ORI	2.2	SHA	273.3100	0.0006	-0.0105	0.0013	-0.0056	273.3110
			B0	DEC	-9.6761	-0.0025	0.0004	-0.0031	-0.0006	-9.6778
42	16	ALPHA ORI	0-1	SHA	271.4913	0.0007	-0.0120	0.0011	-0.0056	271.4916
		BETELGEUSE	M0	DEC	7.4042	-0.0025	0.0003	-0.0016	-0.0003	7.4020
43		BETA AUR	2.1	SHA	270.5029	0.0009	-0.0163	0.0015	-0.0079	270.5036
		MENKALINAN	A0	DEC	44.9467	-0.0025	0.0002	0.0020	0.0004	44.9438

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					o	o	o	o	o	o
44		THETA AUR	2.7	SHA	270.4279	0.0009	-0.0151	0.0013	-0.0070	270.4283
			A0	DEC	37.2122	-0.0025	0.0002	0.0013	0.0003	37.2095
45		BETA CMA	2.0	SHA	264.5563	0.0005	-0.0097	0.0005	-0.0060	264.5578
		MIRZAM	B1	DEC	-17.9447	-0.0025	-0.0003	-0.0037	-0.0005	-17.9469
46	17	ALPHA CAR	-0.9	SHA	264.1288	-0.0000	-0.0049	0.0008	-0.0094	264.1356
		CANOPUS	F0	DEC	-52.6839	-0.0025	-0.0004	-0.0055	-0.0005	-52.6861
47		GAMMA GEM	1.9	SHA	260.8754	0.0009	-0.0128	0.0002	-0.0059	260.8758
		ALHENA	A0	DEC	16.4183	-0.0025	-0.0007	-0.0007	-0.0004	16.4159
48	18	ALPHA CMA A	-1.6	SHA	258.9450	0.0004	-0.0099	-0.0000	-0.0059	258.9464
		SIRIUS	A0	DEC	-16.6869	-0.0024	-0.0008	-0.0036	-0.0003	-16.6895
49		TAU PUP	2.8	SHA	257.6467	-0.0003	-0.0054	-0.0002	-0.0089	257.6525
			K0	DEC	-50.5892	-0.0024	-0.0009	-0.0055	-0.0000	-50.5920
50	19	EPSILON CMA	1.6	SHA	255.5500	0.0002	-0.0087	-0.0004	-0.0065	255.5523
		ADHARA	B1	DEC	-28.9428	-0.0024	-0.0011	-0.0045	-0.0001	-28.9456
51		OMICRON-2 CMA	3.1	SHA	254.4633	0.0002	-0.0092	-0.0005	-0.0062	254.4651
			B5	DEC	-23.8019	-0.0024	-0.0012	-0.0041	-0.0001	-23.8048
52		DELTA CMA	2.0	SHA	253.1158	0.0002	-0.0090	-0.0006	-0.0063	253.1178
		WEZEN	F8	DEC	-26.3592	-0.0023	-0.0013	-0.0043	-0.0000	-26.3621
53		PI PUP	2.7	SHA	250.8996	-0.0002	-0.0078	-0.0009	-0.0070	250.9025
			K5	DEC	-37.0592	-0.0023	-0.0015	-0.0049	0.0003	-37.0625
54		ETA CMA	2.4	SHA	249.1842	0.0000	-0.0087	-0.0010	-0.0064	249.1862
			B5	DEC	-29.2614	-0.0023	-0.0016	-0.0045	0.0002	-29.2647
55		BETA CMI	3.1	SHA	248.4971	0.0008	-0.0120	-0.0010	-0.0056	248.4975
			B8	DEC	8.3325	-0.0022	-0.0017	-0.0015	-0.0006	8.3300
56		SIGMA PUP	3.3	SHA	247.8592	-0.0005	-0.0070	-0.0014	-0.0076	247.8628
			K5	DEC	-43.2583	-0.0022	-0.0017	-0.0051	0.0006	-43.2620
57		ALPHA GEM A	2.0	SHA	246.6850	0.0015	-0.0142	-0.0013	-0.0065	246.6859
		CASTOR	A0	DEC	31.9356	-0.0022	-0.0018	0.0008	-0.0011	31.9335
58		ALPHA GEM B	2.8	SHA	246.6846	0.0015	-0.0142	-0.0013	-0.0065	246.6854
			A0	DEC	31.9356	-0.0022	-0.0018	0.0008	-0.0011	31.9335
59	20	ALPHA CMI A	0.5	SHA	245.4492	0.0008	-0.0118	-0.0012	-0.0055	245.4496
		PROCYON	F5	DEC	5.2794	-0.0022	-0.0019	-0.0018	-0.0005	5.2768
60	21	BETA GEM	1.2	SHA	243.9917	0.0014	-0.0137	-0.0015	-0.0062	243.9924
		POLLUX	K0	DEC	28.0781	-0.0021	-0.0020	0.0004	-0.0011	28.0760
61		ZETA PUP	2.3	SHA	239.2888	-0.0006	-0.0077	-0.0023	-0.0069	239.2912
			O	DEC	-39.9433	-0.0020	-0.0024	-0.0049	0.0010	-39.9476
62		RHO PUP	2.9	SHA	238.3379	-0.0000	-0.0094	-0.0020	-0.0058	238.3389
			F5	DEC	-24.2431	-0.0020	-0.0025	-0.0040	0.0005	-24.2468
63		GAMMA-2 VEL	1.9	SHA	237.7788	-0.0011	-0.0067	-0.0028	-0.0077	237.7820
			O	DEC	-47.2742	-0.0020	-0.0025	-0.0051	0.0014	-47.2788
64	22	EPSILON CAR	1.7	SHA	234.4788	-0.0022	-0.0044	-0.0043	-0.0100	234.4843
		AVIOR	*	DEC	-59.4417	-0.0019	-0.0028	-0.0052	0.0020	-59.4469
65		DELTA VEL	2.0	SHA	228.9692	-0.0020	-0.0060	-0.0045	-0.0083	228.9725
			A0	DEC	-54.6311	-0.0017	-0.0031	-0.0050	0.0022	-54.6366
66		IOTA UMA	3.1	SHA	225.5563	0.0029	-0.0154	-0.0043	-0.0070	225.5584
			A5	DEC	48.1250	-0.0016	-0.0034	0.0018	-0.0027	48.1244

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
67	23	LAMBDA VEL	2.2	SHA	223.1946	-0.0013	-0.0081	-0.0042	-C.0062	223.1955
		SUHAIL	K5	CEC	-43.3475	-0.0015	-0.0035	-0.0045	C.0021	-43.3529
68	24	BETA CAR	1.8	SHA	221.7558	-0.0049	-0.0022	-C.0091	-0.0127	221.7625
		MIAPLACIDUS	A0	CEC	-69.6306	-0.0015	-0.0036	-0.0047	0.0032	-69.6370
69		IOTA CAR	2.2	SHA	220.8679	-0.0029	-0.0058	-0.0063	-C.0085	220.8707
			F0	CEC	-59.1869	-0.0014	-0.0036	-C.0047	C.0029	-59.1931
70		KAPPA VEL	2.6	SHA	219.6342	-0.0024	-0.0067	-0.0058	-C.0074	219.6359
			B3	CEC	-54.9208	-0.0014	-0.0037	-0.0046	0.0028	-54.9269
71	25	ALPHA HYA	2.2	SHA	218.3613	0.0003	-0.0109	-0.0035	-0.0042	218.3604
		ALPHARD	K2	CEC	-8.5669	-0.0013	-0.0038	-0.0028	C.0002	-8.5704
72		N VEL	3.0	SHA	217.3542	-0.0027	-0.0066	-0.0064	-0.0076	217.3558
			K5	DEC	-56.9414	-0.0013	-0.0038	-0.0045	0.0031	-56.9477
73		EPSILCN LEO	3.1	SHA	213.8346	0.0017	-0.0126	-0.0041	-0.0042	213.8342
			G0	DEC	23.8714	-0.0012	-0.0040	-C.0005	-0.0020	23.8703
74	26	ALPHA LEO	1.3	SHA	208.1863	0.0012	-0.0119	-0.0042	-0.0035	208.1850
		REGULUS	B8	DEC	12.0703	-0.0009	-0.0043	-0.0015	-C.0013	12.0685
75		GAMMA-1 LEO	2.6	SHA	205.2958	0.0015	-0.0121	-0.0045	-0.0034	205.2947
		ALGEIBA	K0	CEC	19.9483	-0.0008	-0.0044	-0.001C	-0.0020	19.9473
76		THETA CAR	3.0	SHA	199.4488	-0.0045	-0.0077	-0.0104	-0.0063	199.4467
			B0	DEC	-64.2842	-0.0006	-0.0046	-0.0034	0.0043	-64.2914
77		MU VEL	2.8	SHA	198.5346	-0.0022	-0.0094	-0.007C	-C.0041	198.5317
			G5	DEC	-49.3089	-0.0005	-0.0046	-0.0034	0.0036	-49.3153
78		BETA UMA	2.4	SHA	194.8542	0.0045	-0.0134	-0.0085	-0.0042	194.8561
		MERAK	A0	DEC	56.4953	-0.0004	-0.0047	C.0007	-0.0045	56.4971
79	27	ALPHA UMA	1.9	SHA	194.3892	0.0054	-0.0139	-0.0100	-0.0048	194.3924
		DUBHE	K0	CEC	61.8644	-0.0003	-0.0047	0.0009	-C.0048	61.8665
80		PSI UMA	3.1	SHA	192.8779	0.0032	-0.0126	-0.0067	-C.0030	192.8778
			K0	CEC	44.6125	-0.0003	-0.0048	-C.0001	-0.0040	44.6138
81		DELTA LEO	2.6	SHA	191.7517	0.0016	-0.0118	-0.0052	-0.0022	191.7496
			A3	DEC	20.6389	-0.0002	-0.0048	-C.0014	-0.0022	20.6385
82	28	BETA LEO	2.2	SHA	183.0029	0.0013	-0.0114	-C.0053	-0.0012	182.9998
		DENEBOLA	A2	CEC	14.6894	0.0002	-0.0049	-0.0018	-0.0018	14.6889
83		GAMMA UMA	2.5	SHA	181.8171	0.0041	-0.0117	-0.0087	-C.0018	181.8172
		PHECDA	A0	CEC	53.8114	0.0002	-0.0049	-0.0004	-0.0047	53.8139
84		DELTA CEN	2.9	SHA	178.1842	-0.0024	-0.0114	-0.0081	-0.0012	178.1772
			B3	CEC	-50.6056	0.0004	-C.0049	-0.0021	C.0041	-50.6118
85	29	GAMMA CRV	2.8	SHA	176.3192	-0.0001	-0.0114	-0.0054	-C.0006	176.3139
		GIENAH	B8	CEC	-17.4256	0.0005	-0.0049	-C.0023	0.0013	-17.4289
86	30	ALPHA CRU A	1.6	SHA	173.6450	-0.0042	-0.0122	-0.0115	-0.0006	173.6354
		ACRUX	B1	DEC	-62.9828	0.0006	-0.0049	-0.0014	C.0049	-62.9895
87		ALPHA CRU B	2.1	SHA	173.6425	-0.0042	-0.0122	-0.0115	-0.0006	173.6329
			B3	DEC	-62.9831	0.0006	-0.0049	-0.0014	0.0049	-62.9898
88	31	GAMMA CRU	1.6	SHA	172.5021	-0.0031	-0.0121	-0.0096	-0.0003	172.4932
		GACRUX	M3	DEC	-56.9958	0.0006	-0.0049	-0.0015	0.0045	-57.0022
89		BETA CRV	2.8	SHA	171.6800	-0.0004	-0.0116	-0.0057	-0.0001	171.6739
			G5	DEC	-23.2808	0.0007	-0.0049	-0.0021	0.0019	-23.2845

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
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90		ALPHA MUS	2.9	SHA	171.0208	-0.0057	-0.0130	-0.0146	-0.0001	171.0087
			B3	DEC	-69.0200	0.0007	-0.0049	-0.0010	0.0052	-69.0269
91		GAMMA CEN	2.4	SHA	169.9125	-0.0021	-0.0122	-0.0080	0.0001	169.9042
		MUHLIFAIN	A0	DEC	-48.8447	0.0007	-0.0049	-0.0015	0.0040	-48.8504
92		GAMMA VIR	2.9	SHA	169.8517	0.0006	-0.0114	-0.0052	0.0001	169.8465
			F0	DEC	-1.3344	0.0007	-0.0049	-0.0022	-0.0003	-1.3359
93		BETA CRU	1.5	SHA	168.3792	-0.0034	-0.0128	-0.0103	0.0005	168.3688
		MIMOSA	B1	DEC	-59.5742	0.0008	-0.0049	-0.0011	0.0047	-59.5805
94	32	EPSILON UMA	1.7	SHA	166.7229	0.0042	-0.0098	-0.0094	0.0007	166.7215
		ALIOTH	A0	DEC	56.0736	0.0009	-0.0048	-0.0014	-0.0049	56.0770
95		ALPHA-2 CVN	2.9	SHA	166.2383	0.0026	-0.0105	-0.0067	0.0006	166.2351
		COR CAROLI	A0	DEC	38.4314	0.0009	-0.0048	-0.0019	-0.0038	38.4337
96		EPSILON VIR	2.9	SHA	164.7175	0.0011	-0.0111	-0.0053	0.0006	164.7125
			K0	DEC	11.0717	0.0009	-0.0048	-0.0023	-0.0015	11.0717
97		IOTA CEN	2.9	SHA	160.1471	-0.0010	-0.0125	-0.0064	0.0013	160.1385
			A2	DEC	-36.6019	0.0011	-0.0047	-0.0013	0.0030	-36.6062
98		ZETA UMA	2.4	SHA	159.2296	0.0039	-0.0090	-0.0090	0.0020	159.2270
		MIZAR	A2	DEC	55.0344	0.0012	-0.0047	-0.0020	-0.0048	55.0381
99	33	ALPHA VIR	1.2	SHA	158.9792	0.0002	-0.0117	-0.0053	0.0012	158.9724
		SPICA	B2	DEC	-11.0522	0.0012	-0.0047	-0.0020	0.0007	-11.0540
100		EPSILON CEN	2.6	SHA	155.3629	-0.0023	-0.0139	-0.0085	0.0025	155.3512
			B1	DEC	-53.3603	0.0013	-0.0045	-0.0003	0.0042	-53.3654
101	34	ETA UMA	1.9	SHA	153.3217	0.0032	-0.0089	-0.0078	0.0026	153.3178
		ALKAID	B3	DEC	49.4175	0.0014	-0.0045	-0.0025	-0.0044	49.4210
102		ETA BOO	2.8	SHA	151.5792	0.0014	-0.0106	-0.0053	0.0020	151.5733
			G0	DEC	18.5025	0.0015	-0.0044	-0.0026	-0.0021	18.5038
103		ZETA CEN	3.1	SHA	151.4446	-0.0016	-0.0138	-0.0073	0.0028	151.4334
			B2	DEC	-47.1856	0.0015	-0.0044	-0.0004	0.0037	-47.1900
104	35	BETA CEN	0.9	SHA	149.4179	-0.0029	-0.0155	-0.0099	0.0042	149.4031
		HADAR	B1	DEC	-60.2725	0.0015	-0.0043	0.0004	0.0044	-60.2775
105	36	THETA CEN	2.3	SHA	148.6400	-0.0008	-0.0131	-0.0061	0.0027	148.6300
		MENKENT	K0	DEC	-36.2672	0.0016	-0.0043	-0.0007	0.0028	-36.2706
106	37	ALPHA BOO	0.2	SHA	146.3246	0.0014	-0.0104	-0.0051	0.0025	146.3182
		ARCTURUS	K0	DEC	19.2911	0.0016	-0.0042	-0.0028	-0.0021	19.2927
107		GAMMA BOO	3.0	SHA	142.1921	0.0021	-0.0090	-0.0060	0.0035	142.1862
			F0	DEC	38.3994	0.0018	-0.0040	-0.0032	-0.0034	38.4026
108		ETA CEN	2.6	SHA	141.4583	-0.0010	-0.0140	-0.0063	0.0037	141.4466
			*	DEC	-42.0664	0.0018	-0.0039	-0.0000	0.0030	-42.0696
109	38	ALPHA CEN A	0.3	SHA	140.4563	-0.0025	-0.0168	-0.0094	0.0059	140.4395
		RIGEL KENT.	G0	DEC	-60.7472	0.0018	-0.0039	0.0011	0.0041	-60.7514
110		ALPHA CEN B	1.7	SHA	140.4625	-0.0025	-0.0168	-0.0094	0.0059	140.4458
			K5	DEC	-60.7525	0.0018	-0.0039	0.0011	0.0041	-60.7567
111		ALPHA LUP	2.9	SHA	139.8688	-0.0012	-0.0147	-0.0067	0.0043	139.8559
			B2	DEC	-47.2989	0.0019	-0.0039	0.0004	0.0033	-47.3023
112		EPSILON BOO	2.7	SHA	138.9829	0.0016	-0.0097	-0.0051	0.0034	138.9762
			K0	DEC	27.1619	0.0019	-0.0038	-0.0032	-0.0026	27.1645

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
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159		GAMMA AQL	2.8	SHA	63.6850	0.0004	-0.0105	0.0014	0.0055	63.6746
			K2	DEC	10.5611	0.0021	0.0021	-0.0031	-0.0001	10.5644
160	51	ALPHA AQL	0.9	SHA	62.5604	0.0004	-0.0107	0.0015	0.0055	62.5501
		ALTAIR	A5	DEC	8.8119	0.0021	0.0022	-0.0030	-0.0001	8.8153
161		GAMMA CYG	2.3	SHA	54.6317	-0.0008	-0.0079	0.0028	0.0067	54.6203
			F8	DEC	40.1889	0.0019	0.0027	-0.0048	0.0013	40.1908
162	52	ALPHA PAV	2.1	SHA	54.0017	0.0033	-0.0176	0.0041	0.0093	53.9869
		PEACOCK	B3	DEC	-56.8036	0.0019	0.0028	0.0027	-0.0024	-56.7980
163		ALPHA IND	3.2	SHA	50.9767	0.0026	-0.0156	0.0036	0.0073	50.9642
			K0	DEC	-47.3658	0.0018	0.0030	0.0019	-0.0023	-47.3602
164	53	ALPHA CYG	1.3	SHA	49.8217	-0.0012	-0.0075	0.0036	0.0069	49.8098
		DENEB	A2	DEC	45.2047	0.0017	0.0031	-0.0048	0.0018	45.2062
165		EPSILON CYG	2.6	SHA	48.6600	-0.0006	-0.0088	0.0032	0.0058	48.6492
			K0	DEC	33.8908	0.0017	0.0032	-0.0044	0.0014	33.8928
166		ALPHA CEP	2.6	SHA	40.4804	-0.0034	-0.0050	0.0071	0.0094	40.4651
		ALDERAMIN	A5	DEC	62.4964	0.0014	0.0037	-0.0047	0.0031	62.4966
167		BETA AQR	3.1	SHA	37.3867	0.0009	-0.0116	0.0035	0.0041	37.3776
			G0	DEC	-5.6642	0.0013	0.0038	-0.0018	-0.0008	-5.6602
168	54	EPSILON PEG	2.5	SHA	34.2117	0.0003	-0.0108	0.0037	0.0040	34.2026
		ENIF	K0	DEC	9.7781	0.0012	0.0040	-0.0028	0.0003	9.7809
169		DELTA CAP	3.0	SHA	33.5296	0.0013	-0.0122	0.0039	0.0040	33.5208
			A5	DEC	-16.2233	0.0012	0.0040	-0.0011	-0.0015	-16.2186
170	55	ALPHA GRU	2.2	SHA	28.2717	0.0032	-0.0140	0.0060	0.0051	28.2628
		AL NA'IR	B5	DEC	-47.0633	0.0009	0.0043	0.0009	-0.0036	-47.0567
171		ALPHA TUC	2.9	SHA	25.7317	0.0049	-0.0153	0.0085	0.0066	25.7223
			K2	DEC	-60.3650	0.0008	0.0044	0.0016	-0.0042	-60.3577
172		BETA GRU	2.2	SHA	19.6454	0.0033	-0.0133	0.0066	0.0040	19.6381
			M3	DEC	-46.9950	0.0006	0.0046	0.0004	-0.0039	-46.9882
173	56	ALPHA PSA	1.3	SHA	15.8771	0.0021	-0.0122	0.0054	0.0028	15.8703
		FOMALHAUT	A3	DEC	-29.7339	0.0004	0.0047	-0.0008	-0.0029	-29.7282
174		BETA PEG	2.6	SHA	14.3117	-0.0007	-0.0106	0.0054	0.0026	14.3031
		SCHEAT	M0	DEC	27.9686	0.0003	0.0047	-0.0030	0.0021	27.9692
175	57	ALPHA PEG	2.6	SHA	14.0721	-0.0000	-0.0110	0.0049	0.0023	14.0643
		MARKAB	A0	DEC	15.0919	0.0003	0.0048	-0.0027	0.0010	15.0937
176		GAMMA CEP	3.4	SHA	5.3817	-0.0108	-0.0087	0.0233	0.0066	5.3599
			K0	DEC	77.5153	-0.0001	0.0049	-0.0019	0.0053	77.5124

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A/C 80

Nautical Almanac Office

U. S. Naval Observatory

ALMANAC
FOR
COMPUTERS
1980

Nautical Almanac Office
United States Naval Observatory
Washington, D. C. 20390

Table of Contents

Section A: EXPLANATION

Introduction

This edition of the *Almanac for Computers* (*A/C 80*) employs the basic methods of previous editions to provide astronomical data, in a form suitable for small computers and calculators, for navigation and positional astronomy. Instead of the fixed-interval tabulations of *The American Ephemeris and Nautical Almanac* (*AE*), *The Nautical Almanac* (*NA*) and *The Air Almanac* (*AA*), this volume contains concise mathematical expressions to make possible direct calculations of the coordinates of celestial bodies. Such expressions must take the form of mathematical approximations, however, because the fundamental equations are too complex for direct use in the majority of astronomical and navigational applications. Using the expressions in this volume it is possible to calculate, with minimal loss of precision, the basic data in the *AE*, *NA* and *AA* for specific times and conditions. More specific information about precision is given in Tables 1, 2 and 3 of this section.

New material concerning solar coordinates has been added to the Applications section (Section B). First is a procedure for computing the Sun's position to low precision over a few centuries. The second addition concerns the equation of time and the time of local solar transit. New formulas for the equation of time were derived by Dr. James Brimhall, West Virginia State University; they are published here for the first time.

For most efficient use with computers, the data in Sections D and E are available on punched cards or magnetic tape.

Continued improvements in the *Almanac for Computers* will depend on further input from users. Inquiries, suggestions and comments should be sent to The Director, Nautical Almanac Office, U. S. Naval Observatory, Washington, D. C. 20390.

Day of Month	JANUARY			FEBRUARY			MARCH			APRIL		
	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year
	2444			2444			2444			2444		
1	239.5	Tue.	1	270.5	Fri.	32	299.5	Sat.	61	330.5	Tue.	92
2	240.5	Wed.	2	271.5	Sat.	33	300.5	Sun.	62	331.5	Wed.	93
3	241.5	Thu.	3	272.5	Sun.	34	301.5	Mon.	63	332.5	Thu.	94
4	242.5	Fri.	4	273.5	Mon.	35	302.5	Tue.	64	333.5	Fri.	95
5	243.5	Sat.	5	274.5	Tue.	36	303.5	Wed.	65	334.5	Sat.	96
6	244.5	Sun.	6	275.5	Wed.	37	304.5	Thu.	66	335.5	Sun.	97
7	245.5	Mon.	7	276.5	Thu.	38	305.5	Fri.	67	336.5	Mon.	98
8	246.5	Tue.	8	277.5	Fri.	39	306.5	Sat.	68	337.5	Tue.	99
9	247.5	Wed.	9	278.5	Sat.	40	307.5	Sun.	69	338.5	Wed.	100
10	248.5	Thu.	10	279.5	Sun.	41	308.5	Mon.	70	339.5	Thu.	101
11	249.5	Fri.	11	280.5	Mon.	42	309.5	Tue.	71	340.5	Fri.	102
12	250.5	Sat.	12	281.5	Tue.	43	310.5	Wed.	72	341.5	Sat.	103
13	251.5	Sun.	13	282.5	Wed.	44	311.5	Thu.	73	342.5	Sun.	104
14	252.5	Mon.	14	283.5	Thu.	45	312.5	Fri.	74	343.5	Mon.	105
15	253.5	Tue.	15	284.5	Fri.	46	313.5	Sat.	75	344.5	Tue.	106
16	254.5	Wed.	16	285.5	Sat.	47	314.5	Sun.	76	345.5	Wed.	107
17	255.5	Thu.	17	286.5	Sun.	48	315.5	Mon.	77	346.5	Thu.	108
18	256.5	Fri.	18	287.5	Mon.	49	316.5	Tue.	78	347.5	Fri.	109
19	257.5	Sat.	19	288.5	Tue.	50	317.5	Wed.	79	348.5	Sat.	110
20	258.5	Sun.	20	289.5	Wed.	51	318.5	Thu.	80	349.5	Sun.	111
21	259.5	Mon.	21	290.5	Thu.	52	319.5	Fri.	81	350.5	Mon.	112
22	260.5	Tue.	22	291.5	Fri.	53	320.5	Sat.	82	351.5	Tue.	113
23	261.5	Wed.	23	292.5	Sat.	54	321.5	Sun.	83	352.5	Wed.	114
24	262.5	Thu.	24	293.5	Sun.	55	322.5	Mon.	84	353.5	Thu.	115
25	263.5	Fri.	25	294.5	Mon.	56	323.5	Tue.	85	354.5	Fri.	116
26	264.5	Sat.	26	295.5	Tue.	57	324.5	Wed.	86	355.5	Sat.	117
27	265.5	Sun.	27	296.5	Wed.	58	325.5	Thu.	87	356.5	Sun.	118
28	266.5	Mon.	28	297.5	Thu.	59	326.5	Fri.	88	357.5	Mon.	119
29	267.5	Tue.	29	298.5	Fri.	60	327.5	Sat.	89	358.5	Tue.	120
30	268.5	Wed.	30				328.5	Sun.	90	359.5	Wed.	121
31	269.5	Thu.	31				329.5	Mon.	91			

The Julian Day begins at noon.

Day of Month	MAY Julian Date at 0h	MAY Day of Week	MAY Day of Year	JUNE Julian Date at 0h	JUNE Day of Week	JUNE Day of Year	JULY Julian Date at 0h	JULY Day of Week	JULY Day of Year	AUGUST Julian Date at 0h	AUGUST Day of Week	AUGUST Day of Year
	2444			2444			2444			2444		
1	360.5	Thu.	122	391.5	Sun.	153	421.5	Tue.	183	452.5	Fri.	214
2	361.5	Fri.	123	392.5	Mon.	154	422.5	Wed.	184	453.5	Sat.	215
3	362.5	Sat.	124	393.5	Tue.	155	423.5	Thu.	185	454.5	Sun.	216
4	363.5	Sun.	125	394.5	Wed.	156	424.5	Fri.	186	455.5	Mon.	217
5	364.5	Mon.	126	395.5	Thu.	157	425.5	Sat.	187	456.5	Tue.	218
6	365.5	Tue.	127	396.5	Fri.	158	426.5	Sun.	188	457.5	Wed.	219
7	366.5	Wed.	128	397.5	Sat.	159	427.5	Mon.	189	458 5	Thu.	220
8	367.5	Thu.	129	398.5	Sun.	160	428.5	Tue.	190	459.5	Fri.	221
9	368.5	Fri.	130	399.5	Mon.	161	429.5	Wed.	191	460.5	Sat.	222
10	369.5	Sat.	131	400.5	Tue.	162	430.5	Thu.	192	461.5	Sun.	223
11	370.5	Sun.	132	401.5	Wed.	163	431.5	Fri.	193	462.5	Mon.	224
12	371.5	Mon.	133	402.5	Thu.	164	432.5	Sat.	194	463.5	Tue.	225
13	372.5	Tue.	134	403.5	Fri.	165	433.5	Sun.	195	464.5	Wed.	226
14	373.5	Wed.	135	404.5	Sat.	166	434.5	Mon.	196	465.5	Thu.	227
15	374.5	Thu.	136	405.5	Sun.	167	435.5	Tue.	197	466.5	Fri.	228
16	375.5	Fri.	137	406.5	Mon.	168	436.5	Wed.	198	467.5	Sat.	229
17	376.5	Sat.	138	407.5	Tue.	169	437.5	Thu.	199	468.5	Sun.	230
18	377.5	Sun.	139	408.5	Wed.	170	438.5	Fri.	200	469.5	Mon.	231
19	378.5	Mon.	140	409.5	Thu.	171	439.5	Sat.	201	470.5	Tue.	232
20	379.5	Tue.	141	410.5	Fri.	172	440.5	Sun.	202	471.5	Wed.	233
21	380.5	Wed.	142	411.5	Sat.	173	441.5	Mon.	203	472.5	Thu.	234
22	381.5	Thu.	143	412.5	Sun.	174	442.5	Tue.	204	473.5	Fri.	235
23	382.5	Fri.	144	413.5	Mon.	175	443.5	Wed.	205	474.5	Sat.	236
24	383.5	Sat.	145	414.5	Tue.	176	444.5	Thu.	206	475.5	Sun.	237
25	384.5	Sun.	146	415.5	Wed.	177	445.5	Fri.	207	476.5	Mon.	238
26	385.5	Mon.	147	416.5	Thu.	178	446.5	Sat.	208	477.5	Tue.	239
27	386.5	Tue.	148	417.5	Fri.	179	447.5	Sun.	209	478.5	Wed.	240
28	387.5	Wed.	149	418.5	Sat.	180	448.5	Mon.	210	479.5	Thu.	241
29	388.5	Thu.	150	419.5	Sun.	181	449.5	Tue.	211	480.5	Fri.	242
30	389.5	Fri.	151	420.5	Mon.	182	450.5	Wed.	212	481.5	Sat.	243
31	390.5	Sat.	152				451.5	Thu.	213	482.5	Sun.	244

The Julian Day begins at noon.

Day of Month	SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year	Julian Date at 0^h	Day of Week	Day of Year
	2444			2444			2444			2444		
1	483.5	Mon.	245	513.5	Wed.	275	544.5	Sat.	306	574.5	Mon.	336
2	484.5	Tue.	246	514.5	Thu.	276	545.5	Sun.	307	575.5	Tue.	337
3	485.5	Wed.	247	515.5	Fri.	277	546.5	Mon.	308	576.5	Wed.	338
4	486.5	Thu.	248	516.5	Sat.	278	547.5	Tue.	309	577.5	Thu.	339
5	487.5	Fri.	249	517.5	Sun.	279	548.5	Wed.	310	578.5	Fri.	340
6	488.5	Sat.	250	518.5	Mon.	280	549.5	Thu.	311	579.5	Sat.	341
7	489.5	Sun.	251	519.5	Tue.	281	550.5	Fri.	312	580.5	Sun.	342
8	490.5	Mon.	252	520.5	Wed.	282	551.5	Sat.	313	581.5	Mon.	343
9	491.5	Tue.	253	521.5	Thu.	283	552.5	Sun.	314	582.5	Tue.	344
10	492.5	Wed.	254	522.5	Fri.	284	553.5	Mon.	315	583.5	Wed.	345
11	493.5	Thu.	255	523.5	Sat.	285	554.5	Tue.	316	584.5	Thu.	346
12	494.5	Fri.	256	524.5	Sun.	286	555.5	Wed.	317	585.5	Fri.	347
13	495.5	Sat.	257	525.5	Mon.	287	556.5	Thu.	318	586.5	Sat.	348
14	496.5	Sun.	258	526.5	Tue.	288	557.5	Fri.	319	587.5	Sun.	349
15	497.5	Mon.	259	527.5	Wed.	289	558.5	Sat.	320	588.5	Mon.	350
16	498.5	Tue.	260	528.5	Thu.	290	559.5	Sun.	321	589.5	Tue.	351
17	499.5	Wed.	261	529.5	Fri.	291	560.5	Mon.	322	590.5	Wed.	352
18	500.5	Thu.	262	530.5	Sat.	292	561.5	Tue.	323	591.5	Thu.	353
19	501.5	Fri.	263	531.5	Sun.	293	562.5	Wed.	324	592.5	Fri.	354
20	502.5	Sat.	264	532.5	Mon.	294	563.5	Thu.	325	593.5	Sat.	355
21	503.5	Sun.	265	533.5	Tue.	295	564.5	Fri.	326	594.5	Sun.	356
22	504.5	Mon.	266	534.5	Wed.	296	565.5	Sat.	327	595.5	Mon.	357
23	505.5	Tue.	267	535.5	Thu.	297	566.5	Sun.	328	596.5	Tue.	358
24	506.5	Wed.	268	536.5	Fri.	298	567.5	Mon.	329	597.5	Wed.	359
25	507.5	Thu.	269	537.5	Sat.	299	568.5	Tue.	330	598.5	Thu.	360
26	508.5	Fri.	270	538.5	Sun.	300	569.5	Wed.	331	599.5	Fri.	361
27	509.5	Sat.	271	539.5	Mon.	301	570.5	Thu.	332	600.5	Sat.	362
28	510.5	Sun.	272	540.5	Tue.	302	571.5	Fri.	333	601.5	Sun.	363
29	511.5	Mon.	273	541.5	Wed.	303	572.5	Sat.	334	602.5	Mon.	364
30	512.5	Tue.	274	542.5	Thu.	304	573.5	Sun.	335	603.5	Tue.	365
31				543.5	Fri.	305				604.5	Wed.	366

The Julian Day begins at noon.

Navigational Tables

Section C contains mathematical representations of the following functions that are tabulated in the *Nautical Almanac* (*NA*): the GHA of Aries, the GHA and declination of the Sun, Moon and navigational planets, the semi-diameter of the Sun and Moon, and the horizontal parallax of the Moon. These functions are expressed for a specified time span by a power series of the form

$$f(x) = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + a_4 x^4 + a_5 x^5$$

In the series x is a time-like variable that takes on values between -1 and $+1$ over the specified time span; $a_0, a_1, a_2, a_3, a_4, a_5,$ are coefficients that are tabulated in Section C for the specified time span; and $f(x)$ represents the value of the function (*e.g.*, the GHA of Aries) evaluated at time x.

To evaluate the series for one of the navigational functions, one must first find the set of coefficients in Section C that is applicable for the desired date. Constants A and B are given there for the purpose of converting the calendar date and GMT to the time-like variable x. To obtain the value of x for the desired time, first determine t, the GMT measured in days and fractions thereof from 0 January, 0^h GMT, from the relation $t = N + \mathrm{GMT}/24$, where N is the day of the year at Greenwich and GMT is the Greenwich Mean Time expressed in hours. A calendar is provided on pages A2–A4 for finding the day of the year; alternatively the day of the year can be computed from the formulas given on pages B1 and B2. Once t has been determined, x is computed from the relation $x = t/A + B$. If computed correctly, the value of x will fall in the range of $-1 \leqslant x \leqslant +1$.

Example 1: Compute x for later use in computing the position of the Sun at $10^h 11^m 00^s$ GMT ($=0\overset{d}{.}4243056$) on 25 December 1980.
From the calendar 25 December is found to be day 360. Thus $t = 360 + 0.4243056$. This date is in the interval 30 November through 31 December (days 335 through 366) for which coefficients for the Sun are given on page C6. The constants for this interval are $A = 16.0$ and $B = -21.9375000$. Therefore $x = 360.4243056/16.0 - 21.9375000 = +0.5890191$.

Once the variable x has been computed and the coefficients a_i have been found, the series $f(x) = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + a_4 x^4 + a_5 x^5$ can be evaluated. The series can be evaluated most efficiently by computing a set of five auxiliary variables, $b_1, b_2, b_3, b_4, b_5,$ in the following order:

$$
\begin{aligned}
b_5 &= xa_5 \\
b_4 &= x(a_4 + b_5) \\
b_3 &= x(a_3 + b_4) \\
b_2 &= x(a_2 + b_3) \\
b_1 &= x(a_1 + b_2) \\
f(x) &= a_0 + b_1
\end{aligned}
$$

By using this algorithm, the series is evaluated in its nested form

$$f(x) = a_0 + x(a_1 + x(a_2 + x(a_3 + x(a_4 + xa_5)))).$$

Example 2: Compute the GHA of the Sun at $10^h 11^m 00^s$ GMT on 25 December 1980.

From the previous example $x = +0.5890191$. The coefficients for the Sun's GHA are found on page C6.

b_5 = .5890191 (−0.0059) = −0.0035
b_4 = .5890191 (−0.0038 −0.0035) = −0.0043
b_3 = .5890191 (0.0985 −0.0043) = +0.0555
b_2 = .5890191 (−0.1087 +0.0555) = −0.0313
b_1 = .5890191 (5758.0576 −0.0313) = +3391.5875
$f(+0.5890191)$ = 5941.1098 + 3391.5875 = 9332.6973
Therefore GHA = 332°.6973 = +332°41′.8

Note that when computing the GHA, it may be necessary to reduce the final result to the range 0° – 360° by subtracting multiples of 360°.

Example 3: Compute the declination of the Moon at $15^h 12^m 30^s$ GMT on 10 July 1980.

The constants A and B and series coefficients are found on page C15.

x = 192.6336806 / 3.0 − 63.3333333 = +0.8778935
b_5 = .8778935 (0.0444) = +0.0390
b_4 = .8778935 (0.1465 + 0.0390) = +0.1628
b_3 = .8778935 (−0.9998 + 0.1628) = −0.7348
b_2 = .8778935 (−3.4800 − 0.7348) = −3.7001
b_1 = .8778935 (10.7363 − 3.7001) = +6.1770
$f(+0.8778935)$ = 13.1208 + 6.1770 = +19°.2978
declination = +19°17′.9

Although the series are designed to provide precision comparable to that published in the *NA*, there will be small discrepencies between the tabulated values and the values computed from the series. In such cases it should be understood that the *NA* represents the standard. Table 1 lists the largest discrepencies found from evaluating and comparing the series with the data in the *NA*.

Under no circumstances should the series be used to extrapolate data beyond the specified time intervals. Such extrapolation will lead to erroneous and useless results.

In accordance with standard practice for navigational almanacs, the time argument used in this almanac is Greenwich Mean Time (GMT), or more specifically UT1. To obtain full precision in the determined positions, the radio time signals in UTC must be corrected to UT1, or GMT, according to standard procedures. (See the paper by R.L. Duncombe and P.K. Seidelmann, 'The New UTC Time Signals', *Navigation*, 24, 160–165, 1977.)

Beneath each set of coefficients in Section C is printed the sum of the coefficients. As a check on whether the coefficients have been entered accurately into the calculator, it is recommended that the coefficients be summed and that the resulting sum be compared with the printed sum.

Table 1: Comparison of *Almanac for Computers* with *NA*

Function		No. of Terms	Span of Validity	Maximum Error
GHA of Aries		6	32 days	0′.2
Sun:	GHA	"	"	0′.2
	Declination	"	"	0′.2
	Semi-Diameter	"	"	0′.1
Moon:	GHA	"	6 days	0′.2
	Declination	"	"	0′.2
	Horizontal Parallax	"	"	0′.2
	Semi-Diameter	"	"	0′.1
Navigational Planets:	GHA	"	32 days	0′.2
	Declination	"	"	0′.2

Astronomical Tables

Section D contains mathematical representations of data published in the *American Ephemeris and Nautical Almanac* (*AE*). Chebyshev expansions have been chosen as the means of representation since they provide efficient and accurate expressions that can be easily evaluated with a small computer. The coefficients a_i of the Chebyshev expansion

$$f(x) = a_0/2 + \sum_{i=1}^{n} a_i T_i(x)$$

are tabulated for prescribed time spans, where $f(x)$ is the function being represented, $T_i(x)$ is the Chebyshev polynomial of the first kind of the *i-th* degree, and x is the normalized time variable. Although Chebyshev polynomials appear in the series expansions, the series can be evaluated without explicitly computing these polynomials. No *a prori* knowledge of Chebyshev analysis is required to use the series in this almanac. Interested readers can find information on Chebyshev analysis in *Applied Analysis* by C. Lanczos and *Chebyshev Polynomials in Numerical Analysis* by L. Fox and I. B. Parker.

It must be emphasized that the series are valid only over the specified time intervals. Attempts to extrapolate data using these series will yield erroneous and useless results.

If precision comparable to that of the *AE* is required, the series on pages D3 – D30 should be used. With the exception of the series for the Moon, these series are valid for time spans of approximately three months; for the Moon the span of validity is approximately one month. Table 2 lists the largest errors found by evaluating these series and comparing the results with data printed in the *AE*.

It is possible to develop series that are valid for longer time spans if the precision requirements are relaxed. Such series, valid for one full year, are given on pages D31–D34. Precision criteria of these less precise series are summarized in Table 3.

Chebyshev series can be truncated according to the following precept to obtain shorter series meeting imposed precision limits. Beginning with the last coefficient, add the absolute values of the coefficients until the required limit of precision is accumulated. The series may be safely truncated at this point, and the small terms omitted.

Example 1: For use in the next example, determine the number of terms required to compute the apparent declination of the Sun to $\pm 1''$ ($=0^\circ\!.00028$) on 22 March 1980.

From Table 3 it is seen that the lower precision series on page D31 do not provide the required precision. As shown in Table 2, however, the higher precision series on page D7 provide higher precision than is necessary and

Table 2: Comparison of *Almanac for Computers* and *AE*
(High Precision Series, pp. D3 – D30)

Function		No. of Terms	Span of Validity	Maximum Error	
Apparent Sidereal Time at 0^h UT		36	95 days	$0^{s}.001$	
Equation of the Equinoxes		"	"	$0^{s}.001$	
Nutation in Longitude		"	"	$0''.008$	
Nutation in Obliquity		"	"	$0''.003$	
Sun:	Right Ascension	22	95 days	$0^{s}.02$	
	Declination	"	"	$0''.2$	
	Distance	"	"	4×10^{-7}	AU
	Semi-Diameter	"	"	$0''.01$	
	Ephemeris Transit	"	"	$0^{s}.02$	
Moon:	Right Ascension	34	32 days	$0^{s}.002$	
	Declination	"	"	$0''.02$	
	Horizontal Parallax	"	"	$0''.01$	
	Geocentric Rectangular Coords.	"	"	1×10^{-6}	Earth radii
Mercury:	Right Ascension	38	95 days	$0^{s}.02$	
	Declination	"	"	$0''.3$	
	Distance	"	"	1×10^{-6}	AU
Venus:	Right Ascension	38	95 days	$0^{s}.01$	
	Declination	"	"	$0''.1$	
	Distance	"	"	1×10^{-6}	AU
Mars:	Right Ascension	22	95 days	$0^{s}.02$	
	Declination	"	"	$0''.2$	
	Distance	"	"	1×10^{-6}	AU
Jupiter:	Right Ascension	22	95 days	$0^{s}.01$	
	Declination	"	"	$0''.1$	
	Distance	"	"	1×10^{-6}	AU
Saturn:	Right Ascension	14	95 days	$0^{s}.02$	
	Declination	"	"	$0''.2$	
	Distance	"	"	3×10^{-6}	AU
Uranus:	Right Ascension	14	95 days	$0^{s}.02$	
	Declination	"	"	$0''.2$	
	Distance	"	"	3×10^{-6}	AU
Neptune:	Right Ascension	12	95 days	$0^{s}.02$	
	Declination	"	"	$0''.2$	
	Distance	"	"	1×10^{-5}	AU
Pluto:	Right Ascension (astrometric)	12	95 days	$0^{s}.004$	
	Declination (astrometric)	"	"	$0''.04$	
	Distance	"	"	9×10^{-6}	AU

therefore can be truncated. Summing the absolute values of terms 21 through 10 gives a total of $0\overset{\circ}{.}000212$; adding the absolute value of coefficient 9 gives $0\overset{\circ}{.}000455$, which exceeds the limit of precision. Therefore terms 10 through 21 can be safely dropped, and terms 0 through 9 provide the Sun's declination to $\pm 1''$.

To evaluate the approximations, one must first normalize the time variable to the interval for which the series is valid. The normalized time x is determined from a relation of the form $x = t/A + B$, where values of A and B are given for each set of coefficients and t is reckoned in days and fractions thereof from 0 January. If correctly computed, the value of x will fall in the range $-1 \leqslant x \leqslant +1$.

For the functions Apparent Sidereal Time at 0^h UT, Equation of the Equinoxes, Nutation in Longitude and Nutation in Latitude, the variable t is measured in days of universal time (UT1 to be precise) from 0 January, 0^h UT. For all other functions in Section D, t is measured in days of ephemeris time from 0 January, 0^h ET. These latter functions can be evaluated for universal times, however, by using the normalizing relation $x = (t' + \Delta T)/A + B$, where t' is the universal time measured in days from 0 January, 0^h UT. As this volume goes to press, $\Delta T = 51\overset{s}{.}1 (= 0\overset{d}{.}000591)$ appears to be a reliable value to use in 1980. Care should be taken to verify that the sum $t' + \Delta T$ falls within the time span for which the series is valid; if it falls outside, the series and constants for the next span should be used.

Once the normalized time variable x is determined, the approximation

$$f(x) = a_0/2 + \sum_{i=1}^{n} a_i T_i(x)$$

where the a_i are the printed coefficients, can be evaluated as follows:

let $b_{n+1} = b_{n+2} = 0$,

compute $b_i = 2x b_{i+1} - b_{i+2} + a_i$, for $i = n, n-1, \ldots, 0$,

then $f(x) = (b_0 - b_2)/2$.

Example 2: Compute the apparent declination of the Sun to a precision of $\pm 1''$ at $9^h 44^m 18^s$ UT $(= 0\overset{d}{.}405764)$ on 22 March 1980.

From the previous example we know that terms 0 through 9 of the series on page D7 will provide the required precision. From the calendar (pages A2–A4) or the formulas on pages B1–B2 it is found that 22 March is day 82. Since the series for solar coordinates are based on ephemeris time, it is necessary to add ΔT to the specified universal time. Therefore

Table 3: Comparison of *Almanac for Computers* and *AE*
(Low Precision Series, pp. D31 – D34)

Function		No. of Terms	Maximum Error
Apparent Sidereal Time at 0^h UT		10	$0\overset{s}{.}03$
Equation of the Equinoxes		"	$0\overset{s}{.}03$
Nutation in Longitude		"	$0\overset{''}{.}4$
Nutation in Obliquity		"	$0\overset{''}{.}2$
Sun:	Right Ascension	22	$0\overset{s}{.}6$
	Declination	"	$3''$
	Distance	"	4×10^{-5} AU
	Semi-Diameter	"	$0\overset{''}{.}04$
	Ephemeris Transit	"	$0\overset{s}{.}6$
Mercury:	Right Ascension	50	14^s
	Declination	"	$2\overset{'}{.}2$
	Distance	"	5×10^{-4} AU
Venus:	Right Ascension	50	$0\overset{s}{.}3$
	Declination	"	$3''$
	Distance	"	2×10^{-6} AU
Mars:	Right Ascension	24	$0\overset{s}{.}8$
	Declination	"	$4''$
	Distance	"	4×10^{-5} AU
Jupiter:	Right Ascension	24	$0\overset{s}{.}2$
	Declination	"	$0\overset{''}{.}6$
	Distance	"	4×10^{-5} AU
Saturn:	Right Ascension	16	$0\overset{s}{.}1$
	Declination	"	$0\overset{''}{.}5$
	Distance	"	4×10^{-5} AU
Uranus:	Right Ascension	16	$0\overset{s}{.}1$
	Declination	"	$0\overset{''}{.}2$
	Distance	"	4×10^{-5} AU
Neptune:	Right Ascension	14	$0\overset{s}{.}1$
	Declination	"	$0\overset{''}{.}2$
	Distance	"	5×10^{-5} AU
Pluto:	Right Ascension (astrometric)	14	$0\overset{s}{.}1$
	Declination (astrometric)	"	$0\overset{''}{.}2$
	Distance	"	5×10^{-5} AU

$t = 82^d + 0\overset{d}{.}405764 + 0\overset{d}{.}000591 = 82\overset{d}{.}406355$

On page D7 are found the constants for the time span: $A = 47.5$ and $B = -1.02105263$.

$x = 82.406355/47.5 - 1.02105263 = 0.7138180$

With this value of x and the coefficients on page D7, the algorithm works as follows:

$$
\begin{array}{llllll}
b_{n+2} & = b_{11} & = 0 & & & \\
b_{n+1} & = b_{10} & = 0 & & & \\
b_n & = b_9 & = 2xb_{10} - b_{11} & + a_9 & = & +0.000243 \\
 & \ b_8 & = 2xb_9 - b_{10} & + a_8 & = & +0.000480 \\
 & \ b_7 & = 2xb_8 - b_9 & + a_7 & = & +0.000331 \\
 & \ b_6 & = 2xb_7 - b_8 & + a_6 & = & -0.001386 \\
 & \ b_5 & = 2xb_6 - b_7 & + a_5 & = & +0.002813 \\
 & \ b_4 & = 2xb_5 - b_6 & + a_4 & = & +0.003637 \\
 & \ b_3 & = 2xb_4 - b_5 & + a_3 & = & -0.486495 \\
 & \ b_2 & = 2xb_3 - b_4 & + a_2 & = & +1.132172 \\
 & \ b_1 & = 2xb_2 - b_3 & + a_1 & = & +17.152409 \\
 & \ b_0 & = 2xb_1 - b_2 & + a_0 & = & +2.664561 \\
f(x) & = (b_0 - b_2)/2 & = (2.664561 - 1.132172)/2 & & & \\
\end{array}
$$

$$\text{declination} = +0\overset{\circ}{.}766194 = +0^\circ 45' 58''$$

Beneath each set of coefficients is printed the sum of the coefficients. This may be used as an easy means of verifying the accuracy with which the coefficients have been entered in the computer.

With two exceptions the series in Section D provide data referred to the true equinox and equator of date. The exceptions are

1. the Moon's geocentric, rectangular coordinates (X , Y , Z), which are referred to the mean equator and equinox of 1950.0;
2. the right ascension and declination of Pluto, which are astrometric (*i.e.*, free of the effect of stellar aberration, except for the elliptic part) and are referred to the mean equinox and equator of 1950.0.

The unit of distance for the Sun and planets is the Astronomical Unit; the unit of distance for the Moon is the Earth's equatorial radius.

Stellar Tables

The Stellar Tables (Section E) list the mean and apparent places of 176 stars for the current year, along with coefficients for converting from mean to apparent place for any date in the year. The list of stars is essentially the same as that for the star tables on pages 268–273 of the *Nautical Almanac*. The stars are arranged in order of increasing right ascension (decreasing sidereal hour angle), except where both components of a binary system are listed, in which case the brighter component is listed first. For binary stars that can be resolved in small instruments, the position of one or both components is listed rather than the position of the center of gravity or the center of light. For convenience of navigators the sidereal hour angle (SHA) is tabulated rather than right ascension (RA); astronomers can obtain the right ascension in degrees from the relation RA = 360° – SHA.

The quantities tabulated for each star are, from left to right on the page:

1. Identification number.
2. Navigational star number, provided the star is one of the 57 selected navigation stars listed in the *Nautical Almanac* and *Air Almanac*.
3. Star name. The Bayer designation is on the first line and the proper name, if any, is on the second line.
4. Magnitude and spectral type. The visual magnitude is on the first line, and the spectral type is on the second line. A composite spectrum is denoted by *.
5. Mean place of the star for 1980.0. The SHA in degrees is on the first line; the declination in degrees is on the second line.
6. Four coefficients (H, R, S, C) used in computing the apparent place of the star. The coefficients on the first line are for the computation of apparent SHA; these will hereafter be designated H_S, R_S, S_S, C_S. The coefficients on the second line are for the computation of apparent declination; these will hereafter be designated with the subscript D: H_D, *etc.*
7. Apparent place of the star for 1980.5. The SHA in degrees is on the first line; the declination is on the second line.

The mean place of a star is to be regarded as a fundamental reference point with no simple geometric or observational significance. The apparent place of a star is the geocentric position, referred to the true equinox and equator of date, at which the star is observed. Thus the apparent place is the position needed for navigation, calibration of telescope setting circles, computation of transit times, *etc.* For work requiring accuracies of no better than ±1$'\!.$3, the tabulated apparent place for 1980.5 can be used for any date during the year. To obtain apparent places to greater accuracy, the following procedures should be used:

For the desired date in 1980, determine τ, the fraction of the year elapsed. If the day of the year is t, τ can be computed from the quantities A and B listed at the top of page E3: $\tau = t/A + B$.

Star positions accurate to better than ±0′.5 can be obtained by using the following formulas:

$$\text{apparent SHA} = \text{mean SHA} + H_S + R_S\tau$$
$$\text{apparent decl.} = \text{mean decl.} + H_D + R_D\tau$$

Star positions accurate to better than ±0′.1 (and generally better than ±0′.05) can be obtained from the following formulas:

$$\text{apparent SHA} = \text{mean SHA} + H_S + R_S\tau + S_S \sin 360°\tau + C_S \cos 360°\tau$$
$$\text{apparent decl.} = \text{mean decl.} + H_D + R_D\tau + S_D \sin 360°\tau + C_D \cos 360°\tau$$

The tabulated apparent places for 1980.5 were computed using the latter formulas with $\tau = 0.5$.

To facilitate identification of the 57 standard navigation stars, an index for these stars is provided on page E2.

Example: Compute the apparent place of Rigel (β Orionis) on 14 November to an accuracy of ±0′.1.

From the calendar on pages A2–A4 or the formulas on pages B1–B2, 14 November is found to be day 319. From page E3, A = 366.0 and B = –0.0027. Data for Rigel (Nav. No. 11; A/C ID 29) is found on page E4.

$$\tau = 319/366.0 - 0.0027 = +0.8689$$

	SHA	decl.
Mean place	281°.6058	–8°.2239
$+H$	+ 0.0020	–0.0024
$+R\tau$	– 0.0094	+0.0012
$+S \sin 360°\tau$	– 0.0015	+0.0021
$+C \cos 360°\tau$	– 0.0037	–0.0005
Apparent place	281°.593	–8°.224

Section B: APPLICATIONS

Introduction

In this section reference will be made to the following functions:

Sign function. The sign function serves to extract the algebraic sign from a number. The notation sign(x) is defined to be sign(x) = 1 for $x \geqslant 0$, sign(x) = -1 for $x < 0$. An equivalent definition is sign(x) = $x/|x|$ for $x \neq 0$, sign(x) = 1 for $x = 0$.
Examples: sign(247) = 1, sign(−6.28) = −1.

Truncation or largest-integer function. The truncation function extracts the integral part of a number. The algebraic sign of the result is the same as that of the original number. $\langle x \rangle$ is defined to be $\langle x \rangle = \text{sign}(x) \cdot N$, where N is the largest nonnegative integer such that $N \leqslant |x|$.
Examples: $\langle 17.835 \rangle = 17$, $\langle -3.1416 \rangle = -3$.

Modulus or remainder function. The modulus function yields the remainder of the division x/y, when the quotient is constrained to be an integral value. Thus mod(x,y) is defined to be $\text{mod}(x,y) = x - \langle x/y \rangle \cdot y$.
Examples: mod(11,3) = 2, mod(−764.3,360.0) = −44.3.
Note that $\langle x \rangle = x - \text{mod}(x,1.0)$. Therefore the truncation function can be defined in terms of the modulus function and *vice versa*. If either modulus or truncation is available on a calculator or computer, the other function can be simply obtained.

In this almanac universal time (UT) is to be identified with UT1, which is equivalent to the standard navigational time argument Greenwich Mean Time (GMT). The symbols UT and GMT may therefore be considered interchangable. For detailed information on time systems the reader should consult the Explanation of a current edition of the *American Ephemeris and Nautical Almanac*.

Day of the Year

The day of the year (N) is defined as the integer $N = \langle t \rangle$, where t is the time elasped in days since 0 January of the current year. Thus N is an integer running from 1 through 365 (or 366 in leap years). The day of the year can be computed from either of the following formulas:

$$N = \left\langle \frac{275\,M}{9} \right\rangle - \left\langle \frac{M+9}{12} \right\rangle 1 + \left\langle \frac{K - 4\langle K/4 \rangle + 2}{3} \right\rangle + I - 30$$

$$N = \left\langle \frac{275\,M}{9} \right\rangle - \left\langle \frac{M+9}{12} \right\rangle 1 + \left\langle \frac{\text{mod}(K,4) + 2}{3} \right\rangle + I - 30$$

where N is the day of the year, K is the year (*e.g.*, 1980), M is the month ($1 \leqslant M \leqslant 12$), and I is the day of the month ($1 \leqslant I \leqslant 31$).

These formulas are equivalent and are valid for any year, except those century years that are not evenly divisible by 400. Therefore the formulas given above are

valid for the year 2000, but not for 1900 or 2100. In the above formulas the factor within the parentheses has the value 1 for leap years and 2 for non-leap years. Thus for a non-leap year, the following expression can be used:

$$N = \left\langle \frac{275\,M}{9} \right\rangle - 2\left\langle \frac{M+9}{12} \right\rangle + I - 30$$

For leap years the equivalent expression is

$$N = \left\langle \frac{275\,M}{9} \right\rangle - \left\langle \frac{M+9}{12} \right\rangle + I - 30$$

Many expressions in this almanac require the value of t, the time elasped in days since 0 January, 0^h UT, of the current year. By inverting the definition of N, we obtain $t = N + UT/24$, where UT is the universal time expressed in hours.

Julian Date

The Julian Date (JD) is a continuous count of days and fractions thereof from 1 January 4713 B.C. (=–4712 January 1), Greenwich Mean Noon (=12^h UT). For example A.D. 1978 January 1, 0^h UT, is JD 2443509.5 and A.D. 1978 July 21, 15^h UT, is JD 2443711.125. Conversion of Gregorian Calendar Date to Julian Date for the years A.D. 1801 through A.D. 2099 can be carried out with the following formula:

$$\mathrm{JD} = 367\,K - \left\langle \frac{7(K + \langle (M+9)/12 \rangle)}{4} \right\rangle + \left\langle \frac{275\,M}{9} \right\rangle + I + 1721013.5$$

$$+ \; UT/24 - 0.5 \operatorname{sign}(100\,K + M - 190002.5) + 0.5$$

where K is the year ($1801 \leqslant K \leqslant 2099$), M is the month ($1 \leqslant M \leqslant 12$), I is the day of the month ($1 \leqslant I \leqslant 31$), and UT is the universal time in hours. The last two terms in the formula add up to zero for all dates after 1900 February 28, so these two terms can be omitted for subsequent dates. Note that the formula makes use of the truncation and sign functions defined on page B1.

Example: Compute the JD corresponding to 1877 August 11, $7^h 30^m$ UT.
Substituting $K = 1877$, $M = 8$, $I = 11$, and $UT = 7.5$ in the formula yields
JD = 688859 – 3286 + 244 + 11 + 1721013.5 + 0.3125 + 0.5 + 0.5
= 2406842.8125

The Modified Julian Date (MJD) is sometimes used to specify current dates; it is defined as MJD = JD – 2400000.5. Use of the Modified Julian Date, rather than the Julian Date, is recommended with computers and calculators of limited precision. Note that for 0^h UT on any date the Julian Date has a fractional part of .5, while the corresponding Modified Julian Date is an integer.

If ephemeris time (ET) is used in the above formula instead of universal time (UT), the resulting quantity is designated Julian Ephemeris Date (JED).

Sidereal Time

The following formulas are relevant to the computation of sidereal time:

(1) $\text{GMST} = 6\overset{\text{h}}{.}58852667 + 0\overset{\text{h}}{.}0657098232N + 1.0027379093UT$

(2) $\text{GMST} = 6\overset{\text{h}}{.}67170278 + 0\overset{\text{h}}{.}0657098232(\text{JD0} - 2433282.5) + 1.0027379093UT$

(3) $\Omega = 151\overset{\circ}{.}9504 - 0\overset{\circ}{.}0529539\,(N + UT/24)$

(4) $\Omega = 372\overset{\circ}{.}1133 - 0\overset{\circ}{.}0529539\,(\text{JD} - 2433282.5)$

(5) $E = -0\overset{\text{h}}{.}00029\sin\Omega$

(6) $\text{GAST} = \text{GMST} + E$

(7) $\text{GAST} = \Sigma(t_0) + 1.0027379093UT = \Sigma(t) + UT$

(8) $\text{LAST} = \text{GAST} - \lambda/15$

where

GMST is the Greenwich mean sidereal time in hours;

Ω is the mean longitude of the ascending node of the Moon's orbit, measured in degrees;

E is the equation of the equinoxes in hours;

GAST is the Greenwich apparent sidereal time in hours;

LAST is the local apparent sidereal time in hours;

N is the day of the year ($1 \leqslant N \leqslant 365$ or, during a leap year, $1 \leqslant N \leqslant 366$);

UT is the universal time in hours;

JD0 and JD are the Julian Dates at 0^{h} UT and at an arbitrary time of the day, respectively;

$\Sigma(t_0)$ and $\Sigma(t)$ are values obtained by evaluating the Chebyshev series for Apparent Sidereal Time (pp. D3–D6 or D31) at 0^{h} UT and at an arbitrary time of the day, respectively;

λ is the local longitude in degrees (west is positive; east is negative).

When using the above formulas, it may be necessary to reduce the resulting hour values to the range $0^{\text{h}} - 24^{\text{h}}$ by adding or subtracting multiples of 24^{h}.

Formulas (1) and (3) are specifically for the current year; the other formulas are valid at least over the latter half of this century. Formula (5) is an approximation that is accurate to about $\pm 0\overset{\text{s}}{.}2$. If more accuracy is required, the Chebyshev series for the Equation of the Equinoxes (pp. D3–D6 or D31) can be used in place of Formula (5). If sidereal time is to be computed to an accuracy better than $\pm 0\overset{\text{s}}{.}2$ (rarely justified for practical applications), then *either* the Chebyshev series for the Equation of the Equinoxes should be used in place of Formula (5) *or* Formula (7) should be used in place of Formula (6).

The above formulas can be easily adapted to allow the Modified Julian Date to be used in place of the Julian Date.

Hour Angles

The following formulas are useful if astronomical data, such as that given in Sections C and E, are applied to navigational purposes:

$$\text{GHA} = 15\,(\text{GAST} - \text{RA})$$

$$\text{LHA} = 15\,(\text{LAST} - \text{RA}) = \text{GHA} - \lambda$$

$$\text{GHA Aries} = 15\,\text{GAST}$$

$$\text{SHA} = 360^\circ - 15\,\text{RA}$$

$$\text{GHA} = \text{GHA Aries} + \text{SHA}$$

where

GHA is the Greenwich hour angle in degrees;
LHA is the local hour angle in degrees;
GHA Aries is the Greenwich hour angle of the First Point of Aries (the origin of right ascension) in degrees;
SHA is the sidereal hour angle in degrees;
RA is the apparent right ascension (referred to the true equator and equinox of date) in hours;
λ is the local longitude in degrees (west is positive; east is negative)
GAST is the Greenwich apparent sidereal time in hours;
LAST is the local apparent sidereal time in hours.

When using the above formulas, it may be necessary to add or subtract 360° to reduce the resulting hour angles to the range 0° –360°. Often the local hour angle values are reduced to the range –180° to +180°, in which case they are called meridian angles. In all cases positive hour angle values are measured westward from the meridian.

Altitude and Azimuth

The following formulas can be used to compute the altitude (a) and azimuth (A) of a celestial body:

(1) $\sin a = \cos z = \sin\phi \sin\delta + \cos\phi \cos\delta \cos \text{LHA}$

(2) $x = \tan A = \sin \text{LHA} / (\cos \text{LHA} \sin\phi - \tan\delta \cos\phi)$

Since computers and calculators normally give the arctangent in the range –90° to + 90°, the correct quadrant for A can be selected according to the following rules:

If $0^\circ \leqslant \text{LHA} \leqslant 180^\circ$,

$A = 180^\circ + \arctan x$, if x is positive,
$A = 360^\circ + \arctan x$, if x is negative.

If $180^\circ \leqslant \text{LHA} < 360^\circ$,

$A = \arctan x$, if x is positive,
$A = 180^\circ + \arctan x$, if x is negative.

Notation:

a = altitude of body above (if $\sin a > 0$) or below (if $\sin a < 0$) the horizon;
A = azimuth of body measured eastward from north over the range $0° \leqslant A \leqslant 360°$;
ϕ = latitude of observer (north is positive; south is negative);
δ = declination of body (north is positive; south is negative);
LHA = local hour angle of body;
z = zenith distance of body ($z = 90° - a$).

The standard navigational notation for altitude is Hc, and the navigational notation for azimuth is Zn. Equations (1) and (2) are the basic formulas used in preparing sight reduction tables.

Sunrise, Sunset and Twilight

The following algorithm provides a means of computing times of sunrise, sunset and twilight for the current year for specified locations. Between latitudes 65° North and 65° South the phenomena can be computed to an accuracy of $\pm 2^m$. Although the algorithm can be used at higher latitudes, its accuracy deteriorates near dates on which the Sun remains above or below the horizon for more than twenty-four hours.

Notation:

ϕ = latitude of observer (north is positive; south is negative)
λ = longitude of observer (west is positive; east is negative)
M = Sun's mean anomaly
L = Sun's true longitude
RA = Sun's right ascension
δ = Sun's declination
H = Sun's local hour angle
z = Sun's zenith distance at rise, set or twilight *
t = approximate time of phenomenon in days since 0 Jan., 0^h UT
T = local mean time of phenomenon
UT = universal time of phenomenon

*The proper value of z should be chosen from the following:

	z	$\cos z$
Sunrise and Sunset	90°50′	−0.01454
Civil Twilight	96°	−0.10453
Nautical Twilight	102°	−0.20791
Astronomical Twilight	108°	−0.30902

Formulas for 1980:

(1) $M = 0\overset{\circ}{.}985600t - 3\overset{\circ}{.}763$

(2) $L = M + 1\overset{\circ}{.}916 \sin M + 0\overset{\circ}{.}020 \sin 2M + 282\overset{\circ}{.}605$

(3) $\tan RA = 0.91746 \tan L$

(4) $\sin\delta = 0.39782 \sin L$

(5) $x = \cos H = (\cos z - \sin\delta \sin\phi) / (\cos\delta \cos\phi)$

(6) $T = H + RA - 0\overset{h}{.}065710t - 6\overset{h}{.}589$

(7) $UT = T + \lambda$

Procedure:

1. With an initial value of t, compute M from Eq. (1) and then L from Eq. (2). If a morning phenomenon (sunrise or the beginning of morning twilight) is being computed, construct an initial value of t from the formula
$$t = N + (6^h + \lambda)/24$$
where N is the day of the year (see the calendar on pages A2–A4 or the formulas on page B1) and λ is the observer's longitude expressed in hours. If an evening phenomenon is being computed, use
$$t = N + (18^h + \lambda)/24$$
2. Solve Eq. (3) for RA, noting that RA is in the same quadrant as L. Transform RA to hours for later use in Eq. (6).
3. Solve Eq. (4) for $\sin\delta$ which appears in Eq. (5); $\cos\delta$, which also is required in Eq. (5), should be determined from $\sin\delta$. While $\sin\delta$ may be positive or negative, $\cos\delta$ is always positive.
4. Solve Eq. (5) for H. Since computers and calculators normally give the arccosine in the range $0° - 180°$, the correct quadrant for H can be selected according to the following rules:
   (a) rising phenomena, $H = 360° - \arccos x$;
   (b) setting phenomena, $H = \arccos x$.
   In other words, for rising phenomena H must be either in quadrant 3 or 4 (depending on the sign of $\cos H$), whereas H must be either in quadrant 1 or 2 for setting phenomena. Convert H from degrees to hours for use in Eq. (6).
5. Compute T from Eq. (6), recalling that H and RA must be expressed in hours. If T is negative or greater than 24^h, it should be converted to the range $0^h - 24^h$ by adding or subtracting multiples of 24^h.
6. Compute UT from Eq. (7), where λ must be expressed in hours. UT is an approximation to the time of sunrise, sunset or twilight, referred to the Greenwich meridian. If UT is greater than 24^h, the phenomenon occurs on the following day, Greenwich time. If UT is negative, the phenomenon occurs on the previous day, Greenwich time.

To ensure that precision is not lost during the computations, t should be carried to four decimal places. Angles should be expressed to three decimals of a degree and, upon conversion, to three decimals of an hour. Five significant digits should be carried for the trigonometric functions.

Under certain conditions Eq. (5) will yield a value of $|\cos H| > 1$. This mathematical embarrassment indicates the absence of the phenomenon on that day. At far northern latitudes, for example, there is continuous illumination during certain summer days and continuous darkness during winter days.

Example: Compute the time of sunrise on 25 June at Wayne, New Jersey.

Latitude: = $40^{\circ}.9$ North Longitude: = $74^{\circ}.3$ West

$\lambda = +74^{\circ}.3/15 = 4^{h}.95$

$\phi = +40^{\circ}.9$ $\sin\phi = 0.65474$ $\cos\phi = 0.75585$

For sunrise: $z = 90^{\circ}50'$ $\cos z = -0.01454$

$t = 177^{d} + (6^{h} + 4^{h}.95)/24 = 177^{d}.456$

$M = 0^{\circ}.985600\,(177^{d}.456) - 3^{\circ}.763 = 171^{\circ}.138$

$L = 171^{\circ}.138 + 1^{\circ}.916\,(0.15406) \quad 0^{\circ}.020\,(-0.30444) + 282^{\circ}.605$

$= 454^{\circ}.032 = 94^{\circ}.032$

$\tan RA = 0.91746\,(-14.187) = -13.016$

$RA = 94^{\circ}.393 = 6^{h}.293$ Since L is in quadrant 2, so is RA.

$\sin\delta = 0.39782\,(0.99752) = 0.39684$

$\cos\delta = 0.91789$

$x = \cos H = [-0.01454 - (0.39684)(0.65474)]/[(0.91789)(0.75585)]$

$= -0.39546$

Since sunrise is being computed, $H = 360^{\circ} - 113^{\circ}.295 = 246^{\circ}.705 = 16^{h}.447$

$T = 16^{h}.447 + 6^{h}.293 - 0^{h}.065710\,(177^{d}.456) - 6^{h}.589 = 4^{h}.490$

$UT = 4^{h}.490 + 4^{h}.95 = 9^{h}.44$

Sunrise occurs at $9^{h}26^{m}$ UT = $5^{h}26^{m}$ EDT

Example: Compute the end of nautical evening twilight on 1 October at latitude $6^{\circ}.0$ South, longitude $117^{\circ}.0$ East.

$\lambda = -117^{\circ}.0/15 = -7^{h}.80$

$\phi = -6^{\circ}.0$ $\sin\phi = -0.10453$ $\cos\phi = 0.99452$

For nautical twilight: $z = 102^{\circ}$ $\cos z = -0.20791$

$t = 275^{d} + (18^{h} - 7^{h}.80)/24 = 275^{d}.425$

$M = 0^{\circ}.985600\,(275^{d}.425) - 3^{\circ}.763 = 267^{\circ}.696$

$L = 267^{\circ}.696 + 1^{\circ}.916\,(-0.99919) + 0^{\circ}.020\,(0.08034) + 282^{\circ}.605$

$= 548^{\circ}.388 = 188^{\circ}.388$

$\tan RA = 0.91746\,(0.14746) = 0.13528$

$RA = 187^{\circ}.704 = 12^{h}.514$ Since L is in quadrant 3, so is RA.

$\sin\delta = 0.39782\,(-0.14588) = -0.05803$

$\cos\delta = 0.99831$

$x = \cos H = [-0.20791 - (-0.05803)(-0.10453)]/[(0.99831)(0.99452)]$

$= -0.21552$

Since the end of nautical evening twilight is being computed, $H = 102^{\circ}.446$

$H = 6^{h}.830$

$T = 6^{h}.830 + 12^{h}.514 - 0^{h}.065710\,(275^{d}.425) - 6^{h}.589 = -5^{h}.343$

$= 18^{h}.657$

$UT = 18^{h}.657 - 7^{h}.800 = 10^{h}.857$

End of evening nautical twilight occurs at $10^{h}51^{m}$ UT

Solar Coordinates

The true geocentric longitude of the Sun (λ) can be computed to an accuracy of ± 1 minute of arc from the following formulas:

$$M = 358\overset{\circ}{.}476 + 35999\overset{\circ}{.}050T$$
$$L = 279\overset{\circ}{.}691 + 36000\overset{\circ}{.}769T$$
$$\lambda = L + (1\overset{\circ}{.}919 - 0\overset{\circ}{.}0048T)\sin M + 0\overset{\circ}{.}020 \sin 2M$$

where $T = (\mathrm{JD} - 2415020.0)/36525$ and JD is the Julian Date (see page B2).

If we consider the Sun's latitude to be identically zero, the right ascension (RA) and declination (δ) of the Sun can also be computed to ± 1 minute of arc from

$$\tan RA = \cos\epsilon \ \tan\lambda$$
$$\sin\delta = \sin\epsilon \ \sin\lambda$$

where ϵ, the obliquity of the ecliptic, can be computed from $\epsilon = 23\overset{\circ}{.}452 - 0\overset{\circ}{.}013T$. The right ascension is always in the same quadrant as the true longitude.

Because the obliquity varies slowly, a single value can be used for an extended period of time. During the last quarter of the twentieth century, $\epsilon = 23\overset{\circ}{.}441$ is sufficiently accurate. Similarly the coefficient of $\sin M$ in the equation for λ changes slowly; for the last half of the twentith century a value of $1\overset{\circ}{.}916$ can be safely used.

Although there is no rigorous limit on the time span for which these formulas are valid, their accuracy gradually deteriorates for values of T greater than a couple of centuries.

Equation of Time and Time of Solar Transit

The equation of time (EqT) is the hour angle of the true Sun minus the hour angle of the mean sun. Thus it is the difference: apparent solar (sundial) time minus mean solar (clock) time.

For the current year EqT can be computed to an accuracy of ± 0.8 minute from the following formula:

$$(1)\ EqT = -7\overset{m}{.}64 \sin(0\overset{\circ}{.}9856\,t) + 0\overset{m}{.}56 \cos(0\overset{\circ}{.}9856\,t) - 9\overset{m}{.}37 \sin(1\overset{\circ}{.}9712\,t) - 2\overset{m}{.}83 \cos(1\overset{\circ}{.}9712\,t)$$

where t is the number of days since 0 January, 0^{h} UT.

If higher accuracy is required the following formulas will give EqT to an accuracy of ± 2 seconds during the current year:

$$(2)\ \theta = 8\overset{\circ}{.}825 + 0\overset{\circ}{.}98561\,t + 1\overset{\circ}{.}916 \sin(0\overset{\circ}{.}9856\,t - 3\overset{\circ}{.}780) + 0\overset{\circ}{.}020 \sin(1\overset{\circ}{.}9712\,t - 7\overset{\circ}{.}560)$$

$$(3)\ EqT = 35\overset{m}{.}302 + 3\overset{m}{.}94244\,t - 4\overset{m}{.}0 \arctan[(\tan\theta)/0.91746]$$

where t is the number of days, and fractions thereof, since 0 January, 0^{h} UT. In Eq. (3) the arctangent should yeild a result in degrees that is in the same quadrant as θ. Near the end of the year θ becomes greater than 360°. When this occurs the arctangent in Eq. (3) should also be greater than 360°.

Eqs. (2) and (3) can be used to compute the time at which the Sun transits the local meridian. First use Eqs. (2) and (3) to compute EqT for $t = N + (12^h + \lambda)/24$, where N is the day of the year (see the calendar on pages A2–A4 or the formulas on pages B1–B2) and λ is the west longitude expressed in hours. Then the local mean time (LMT) of transit is given to an accuracy of ±2 seconds by $LMT = 12^h - EqT$. The universal time of local transit is then obtained from $UT = LMT + \lambda$.

Example: Compute the time of solar transit at longitude 81°38ʹ.0 West on
22 September 1980.

$\lambda = +81^\circ\!.633/15 = +5^h\!.4422$

For solar transit: $t = 266^d + (12^h + 5^h\!.4422)/24 = 266^d\!.72676$

$\theta = 8^\circ\!.825 + 0^\circ\!.98561\,(266^d\!.72676) + 1^\circ\!.916\,(-0.9820)$
$\quad + 0^\circ\!.020 \quad (+0.3712) = 269^\circ\!.839$

$EqT = 35^m\!.302 + 3^m\!.94244\,(266^d\!.72676) - 4^m\!.0 \arctan\,[355.8735 / 0.91746]$
$\quad = 35^m\!.302 + 1051^m\!.554 - 4^m\!.0\,(269^\circ\!.852) = 7^m\!.447$

$LMT = 12^h 00^m - 7^m\!.447 = 11^h 52^m\!.553$

$UT = 11^h 52^m\!.553 + 5^h 26^m\!.533 = 17^h 19^m 05^s$ UT

Eastern Daylight Time $= 13^h 19^m 05^s$

Moonrise and Moonset

Times of moonrise and moonset can be computed for specified locations using the following algorithm. Between latitudes 60° North and 60° South, the phenomena can be computed to an accuracy of $\pm 5^m$. Although the algorithm can be used at higher latitudes, its accuracy deteriorates near dates on which the Moon remains above or below the horizon for more than twenty-four hours.

Notation:
- ϕ = latitude of observer (north is positive; south is negative)
- λ = longitude of observer (west is positive; east is negative)
- t_i = *i-th* approximation to universal time of phenomenon, expressed in days from 0 January, 0^h UT
- GHA_i = Moon's GHA at time t_i
- δ_i = Moon's declination at time t_i (north is positive; south is negative)
- τ_i = *i-th* correction to t_0, thus $t_i = t_0 + \tau_i$
- H_i = *i-th* approximation to Moon's LHA at time of rise or set
- ΔH_i = *i-th* approximation to Moon's daily rate of change in GHA

Formulas:

(1) $\Delta H_i = (GHA_i - (GHA_0) / \tau_i$ for $i = 0$, let $\Delta H_0 = 347^\circ\!.81$

(2) $x_{i+1} = \cos H_{i+1} = (.00233 - \sin\phi \, \sin\delta_i) / (\cos\phi \, \cos\delta_i)$

(3) $\tau_{i+1} = (H_{i+1} - H_0) / \Delta H_i$

(4) $t_{i+1} = t_0 + \tau_{i+1}$

Procedure:

1. Let $t_0 = N + (12^h + \lambda)/24$, where N is the day of the year (see the calendar on pages A2–A4 or the formulas on page B1) and λ is the observer's longitude expressed in hours. Set $i = 0$ and begin the following iterative process.
2. For time t_i compute the Moon's GHA and declination to navigational precision ($\pm 0'.1$). Label these quantities GHA_i and δ_i, respectively, where i specifies the iteration number. For $i = 0$, compute $H_0 = GHA_0 - \lambda$.
3. If $i = 0$, let $\Delta H_0 = 347^\circ.81$. Otherwise compute ΔH_i from Eq. (1). If $\Delta H_i < 0$, add $360^\circ / |\tau_i|$ to ΔH_i.
4. Solve Eq. (2) for H_{i+1}. Since computers and calculators normally give the arccosine in the range $0^\circ - 180^\circ$, the correct quadrant for H_{i+1} can be selected according to the following rules:
   (a) moonrise computations, $H_{i+1} = 360^\circ - \arccos x_{i+1}$;
   (b) moonset computations, $H_{i+1} = \arccos x_{i+1}$.
   In other words, near the time of moonrise H_{i+1} must be either in quadrant 3 or 4 (depending on the sign of $\cos H_{i+1}$); near moonset H_{i+1} must be either in quadrant 1 or 2. For latitudes higher than 60° (*i.e.*, $|\phi| > 60^\circ$), the condition $|\cos H_{i+1}| > 1$ can occur, thereby indicating the absence of the phenomenon on that day.
5. Compute τ_{i+1} from Eq. (3). If $|\tau_{i+1}| < 0^d.5$, proceed to Step 6. If $|\tau_{i+1}| > 0^d.5$, the phenomenon being computed occurs on the day prior to the day desired (if τ_{i+1} is negative) or on the day following the day desired (if τ_{i+1} is positive). Normally the phenomenon on the desired day can be obtained by adding to τ_{i+1} (if τ_{i+1} is negative), or subtracting from τ_{i+1} (if τ_{i+1} is positive), $360^\circ / \Delta H_i$. If successful this technique will produce a new value of τ_{i+1} in the required range. However, two conditions may prevent the reduction to $|\tau_{i+1}| < 0^d.5$:
   (a) for low values of i, τ_{i+1} may be a fairly crude approximation to the ultimate value, τ_n;
   (b) each month there is one day (near last quarter) on which there is no moonrise, and another day (near first quarter) on which there is no moonset.
   If $|\tau_{i+1}| \approx 0^d.5$, it is probably worth attempting another iteration to see if $|\tau_{i+2}| < 0^d.5$.
6. Compute t_{i+1} from Eq. (4). If $|t_{i+1} - t_i| < 0^d.01$, t_{i+1} is accurate to $\pm 5^m$. Otherwise it is necessary to iterate the solution by setting $i = i + 1$ and executing Steps 2 through 6 again.

Example: Compute moonrise on 29 June 1980 at latitude 60° 10′ North and longitude 24° 57′ East.

$\phi = +60^\circ.167$ $\quad$ $\sin\phi = 0.86748$ $\quad$ $\cos\phi = 0.49748$

$\lambda = -24^\circ.950 = -1^h.663$

From the calendar on pages A2–A4 or the formulas on pages B1–B2, 29 June

is found to be day 181; therefore

$t_0 = 181^d + (12^h - 1^h.663)/24 = 181^d.43069$

$i = 0$:

$GHA_0 = 140°.380 \qquad \delta_0 = -19°.260$

$H_0 = 140°.380 + 24°.950 = 165°.330$

$\Delta H_0 = 347°.81$

$\cos H_1 = [0.00233 - (0.86748)(-0.32986)] / [(0.49748)(0.94403)]$
$= 0.61426$

Since moonset is sought, H_1 is in quadrant 1 or 2:

$H_1 = 52°.102$

$\tau_1 = (52°.102 - 165°.330)/347°.81 = -0^d.32555$

$|\tau_1| < 0^d.5$ as is required.

$t_1 = 181^d.43069 - 0^d.32555 = 181^d.10514 = $ 29 June $02^h 31^m$ UT

$i = 1$:

$GHA_1 = 27°.546 \qquad \delta_1 = -19°.526$

$\Delta H_1 = (27°.546 - 140°.380)/ -0^d.32555 = 346°.595$

$\cos H_2 = [0.00233 - (0.86748)(-0.33423)] / (0.49748)(0.94249)$
$= 0.62335$

Since moonset is sought, H_2 is in quadrant 1 or 2:

$H_2 = 51°.439$

$\tau_2 = (51°.439 - 165°.330)/346.595 = -0^d.32860$

$t_2 = 181^d.43069 - 0^d.32860 = 181^d.10209 = $ 29 June $02^h 27^m$ UT

$|t_2 - t_1| = 0^d.003 < 0^d.01$

The extremely rapid convergence illustrated in this example occurs frequently but not invariably. Although the first approximation (t_1) will often give adequate precision for most purposes, it is recommended that the solution be iterated and that the convergence criterion ($|t_{i+1} - t_i| < 0^d.01$) be tested.

Polaris (Pole Star)

The following formulas are relevant to observations of Polaris:

(1) $\phi = a - p \cos h + 0.5p \sin p \sin^2 h \tan\phi$

(2) $A \cos\phi = p \sin h + p \sin p \sin h \cos h \tan\phi$

where p is the polar distance of Polaris: $p = 90° -$ declination of Polaris
h is the LHA of Polaris: h = GHA Aries + SHA Polaris + east (−west) longitude of observer

ϕ is the observer's latitude;
A is the azimuth of Polaris;
a is the corrected altitude of Polaris.

Eq. (1) permits the observer's latitude to be determined from an observation of the altitude of Polaris (corrected for refraction, dip, *etc.*). Assumed values of the observer's latitude and longitude can be used for the right side of Eq. (1). Eq. (2) yields the azimuth of Polaris if the observer's position is known. These expressions are accurate only for Polaris, since they depend on p being a small quantity. The SHA and declination of Polaris to be used in these formulas should be referred to the true equator and equinox of date; *i.e.*, the apparent place of Polaris should be computed (see Section E 'Stellar Tables'; Polaris is star number 17).

Equation of Position Line

The following formula can be used to obtain a line of position (LOP) directly from an observation of the altitude of a celestial body:

$$\lambda = \text{GHA} \pm \arccos\left[(\sin a - \sin\phi \sin d) / \cos\phi \cos d\right]$$

where: λ is the computed longitude;
GHA is the GHA of the body for the time of observation;
a is the corrected altitude of the body;
d is the declination of the body for the time of observation;
ϕ is an estimate of the observer's latitude.

North latitudes and west longitudes are positive; south latitudes and east longitudes are negative. Longitudes with absolute values greater than 180° may be encountered. In the above formula, + is used for bodies east of the meridian (rising) and − for bodies west of the meridian (setting).

The formula gives the longitude λ at which the position line crosses the parallel of latitude ϕ. Repeated application of the formula using different values of latitude yields a locus of points all lying in the LOP. Note that no assumed position is necessary, although an estimate of the observer's latitude is helpful in reducing the number of times the formula is applied.

The formula becomes indeterminate at the transit time of a body and for latitudes that the position line does not cross at any point.

Motion of Body and Motion of Observer

The following formula gives the change of altitude of a celestial body, due to the rotation of the Earth, in the time interval Δt (*e.g.*, the interval between a sextant observation and the time of a fix). This correction may be applied to the observed altitude to permit the use of a common assumed position and LHA Aries for observations made at different times.

$$MOB = 15.04\ \Delta t \cos\phi \sin A$$

where MOB is the altitude correction in minutes of arc, Δt is the time difference in minutes, ϕ is the latitude of the observer, and A is the azimuth of the observed body. If the time of the fix is later than the time of observation, MOB should be added to the observed altitude.

The following formula gives the change of altitude of a celestial body, due to the motion of the observer, in the time interval Δt (*e.g.*, the interval between a sextant observation and the time of a fix). This correction may be applied to the altitude in lieu of advancing or retiring a line of position.

$$MOO = \frac{v\,\Delta t}{60}\cos(A-C)$$

where MOO is the altitude correction in minutes of arc, Δt is the time difference in minutes, A is the azimuth of the observed body, C is the track/course angle, and v is the ground speed in knots. If the time of the fix is later than the time of observation, MOO should be added to the observed altitude.

These formulas are approximations; they become unreliable for values of Δt greater than 5 minutes.

Sextant Altitude Corrections

Several corrections must be applied to a sextant altitude (hs) in order to obtain a corrected altitude (Ho). Ho can then be either (a) compared with the computed altitude (Hc) to obtain the altitude difference (Δa); or (b) used in the 'Equation of Position Line' (see p. B12) to obtain directly the location of the LOP for the sight.

The corrections, in the order in which they should be applied, are:

(1) Instrument and/or index correction, IC;
(2) Dip of Horizon, D (marine sextant); or Coriolis correction, Δz (bubble sextant);
(3) Atmospheric refraction, R;
(4) Semi-diameter, SD (marine sextant, Sun and Moon observations);
(5) Parallax in altitude, PA (Moon, Venus and Mars observation).

In mathematical notation:

$$\mathrm{Ho} = \mathrm{hs} + \mathrm{IC} + (\mathrm{D} \text{ or } \Delta z) - \mathrm{R} + \mathrm{SD} + \mathrm{PA}$$

If Venus is observed, an additional correction for the phase of the planet may be necessary. This correction can be made either to the sextant altitude or to the GHA or LHA of Venus.

Descriptions and formulas for D, Δz, R, SD, PA and the phase correction for Venus are given on the following pages.

Dip of Horizon

The dip of the apparent horizon from a horizontal plane is given by

$$\mathrm{D} = -0.97\sqrt{h}$$

where h is the height of eye level of the observer in feet and D is the dip of the horizon in minutes of arc. For observations of a celestial body made with a marine sextant or similar instrument, D should be added to the observed altitude to obtain the corrected altitude. This formula is an approximation; the apparent dip varies with atmospheric conditions.

Coriolis Correction

Any object moving across or above the surface of the rotating Earth is subject to an apparent force tending to push the object to the right in the northern hemisphere and to the left in the southern hemisphere. This Coriolis acceleration manifests itself as a deflection of the apparent vertical by an amount Z:

(1) $$Z = 2.62\, V \sin\phi + 0.146\, V^2 \sin C \tan\phi - 5.25\, VC'$$

where: Z is the deflection in minutes of arc;
V is the speed in hundreds of knots;
ϕ is the latitude;
C is the true track/course angle;
C' is the rate of change of true track/course angle in degrees per minute of time.

Usually only the first term on the right of Eq. (1) is significant.

Observations of the altitudes of celestial bodies made with bubble sextants or similar artificial horizon instruments must be corrected for the Coriolis effect. The correction Δz, which can be added to the observed (*e.g.*, bubble sextant) altitude, is given approximately by

(2) $$\Delta z = Z \sin(A - C)$$

where: Δz is the altitude correction in minutes of arc;
Z is the deflection of the vertical determined from Eq. (1);
A is the azimuth of observed body;
C is the true track/course angle.

In the northern hemisphere the correction Δz is positive for stars on the right and negative for stars on the left of the aircraft. In the southern hemisphere the correction is negative for stars on the right and positive for stars on the left.

Atmospheric Refraction

The Earth's atmosphere tends to refract light in such a way that celestial bodies appear slightly higher in the sky than they would if there were no atmosphere. The formulas below can be used to determine R, the angle of refraction. R should be subtracted from an observed (*e.g.*, sextant) altitude to obtain the corrected altitude.

(1) $$R = \frac{P}{273 + T}\,[3.430289\,(z - \arcsin\,[0.9986047 \sin(0.9967614z)]) - 0.01115929z]$$

(2) $$R = \exp(-h/27000) \tan z = 1/[\exp(h/27000) \tan a]$$

where: R is the refraction correction in minutes of arc;
a is the observed altitude
z is the observed zenith distance in degrees: $z = 90° - a$

T is the temperature in degrees Celsius;
P is the atmospheric pressure in millibars;
h is the height of the observer above sea level in feet.

Eq. (1) is more suitable for surface observations, while Eq. (2) is more suitable for observations from aircraft. Both formulas are approximations and are not equivalent to a complete theory of refraction. Eq. (2), which should be used only for altitudes greater than 10°, is accurate to about 0′.2. Eq. (1) can be used for all altitudes: for altitudes greater than 15°, it is accurate to 0′.1 or better; for altitudes between 3° and 15°, errors between 0′.1 and 1′.0 may arise; for altitudes less than 3°, errors between 1′ and 3′ may be expected.

Semi-diameter of the Sun and Planets

When not available directly from almanac data, the semi-diameters of the Sun and planets can be computed from

$$SD = S/d = S\pi/8.794$$

where: SD is the semi-diameter in seconds of arc;
S is the semi-diameter at unit distance (1 AU) in seconds of arc;
d is the geocentric distance in AU;
π is the horizontal parallax in seconds of arc.

The following values of S should be used;

Sun	959″.63	Jupiter	98″.47
Mercury	3.34	Saturn	83.33
Venus	8.41	Uranus	34.28
Mars	4.68	Neptune	36.56

These values apply to the equatorial dimensions of the bodies and do not include any adjustments for irradiation.

Semi-diameter of the Moon

When not available directly from almanac data, the semi-diameter of the Moon can be computed from

(1) $$SD = 56204.92/d = 0.272476\pi$$

where SD is the semi-diameter in seconds of arc, d is the geocentric distance of the Moon in units of the Earth's equatorial radius, and π is the horizontal parallax of the Moon in seconds of arc.

Computed this way, the semi-diameter applies to a fictitious observer located at the center of the Earth. The observed semi-diameter of the Moon will be slightly greater than the geocentric semi-diameter, since a real observer located on the surface of the Earth will be slightly closer to the Moon (assuming it is above the horizon). For navigation and certain other purposes the *augmented semi-diamter* of

the Moon should be used:

(2) $$SD_{aug} = SD[1 + (\sin a)/d]$$

where SD_{aug} is the augmented semi-diameter in seconds of arc, a is the altitude of the Moon (for navigational purposes a = Ho, but hs or Hc can be used instead with negligible error), d is the geocentric distance of the Moon in units of the Earth's equatorial radius, and SD is the geocentric semi-diameter computed from Eq.(1). For navigational purposes a constant value of $d = 60.27$ can be used to sufficient accuracy. The increase in the Moon's semi-diameter due to augmentation is zero when the Moon is on the horizon and is about $0'.3$ when the Moon is at the zenith.

Parallax in Altitude

The finite size of the Earth causes a parallactic shift in the apparent positions of nearby celestial objects. The resulting parallax in altitude can be computed from

$$\sin PA = \sin\pi \cos a$$

where PA is the parallax in altitude, π is the horizontal parallax, and a is the observed altitude. When the horizontal parallax of a body is not available, it may be computed from the relation $\pi = 8''.794/d$, where d is the geocentric distance of the body in astronomical units. The parallax in altitude can exceed $1'$ only for the Moon. Since parallax tends to decrease the apparent altitude of a body, the quantity PA should be added to an observed (*e.g.*, sextant) altitude in order to obtain the corrected altitude. To a reasonable approximation, PA can also be computed from

$$PA = \pi \cos a$$

Correction for the Phase of Venus

When the altitude of Venus is observed with a small instrument, a correction to the observed altitude is required to account for the fact that the center of light, rather than the center of the disk, is observed. This correction has the form $-k \cos\theta$, where k is a correction factor (given below) and θ is the angle on the celestial sphere, at the position of Venus, between the observer's vertical and the direction of the Sun. The correction, which should be added to the observed (*e.g.*, sextant) altitude, is positive when the Sun is lower than Venus, zero when they have the same altitude, and negative when the Sun is higher.

In sight reduction this effect can be approximately taken into account by correcting the GHA (or LHA) of Venus rather than correcting the observed altitude. Simply add k to the GHA (or LHA) of Venus when Venus is east of the Sun (*i.e.*, when Venus is an evening planet), and subtract k from the GHA (or LHA) when Venus is west of the Sun (morning planet). The correction should not be applied in this way near the time of superior or inferior conjunction.

Venus is at inferior conjunction on 15 June 1980. Prior to this date Venus is in the evening sky. Following inferior conjunction Venus is in the morning sky.

The values of k for 1980 are:

		k
Jan.	1	
		0.0
Feb.	29	
		0.1
Apr.	21	
		0.2
May	14	
		0.3
May	30	
		0.4
July	1	
		0.3
July	17	
		0.2
Aug.	9	
		0.1
Sept.	29	
		0.0
Dec.	31	

Section C: NAVIGATIONAL TABLES

DAYS 1 THRU 32 JD 2444239.5 TO 2444271.5 DATES JAN 1 THRU FEB 1

A = 16.00000000 B = -1.06250000

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	6235.5817	6297.5650	-20.9445	0.2717
1	5775.7718	5758.6292	3.0437	0.0
2	0.0009	0.3660	0.8508	0.0
3	-0.0035	0.0465	-0.0595	0.0
4	-0.0010	-0.0115	-0.0045	0.0
5	0.0023	0.0046	0.0007	0.0
SUMS	12011.3522	12056.5998	-17.1133	0.2717

DAYS 32 THRU 63 JD 2444270.5 TO 2444302.5 DATES FEB 1 THRU MAR 3

A = 16.00000000 B = -3.00000000

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	5906.1369	5936.4673	-12.3495	0.2698
1	5775.7702	5760.2361	5.5453	0.0004
2	0.0006	0.3806	0.4195	0.0027
3	0.0009	-0.0266	-0.0760	-0.0046
4	-0.0008	-0.0069	0.0023	-0.0017
5	-0.0009	-0.0028	-0.0018	0.0036
SUMS	11681.9069	11697.0477	-6.4602	0.2702

DAYS 61 THRU 92 JD 2444299.5 TO 2444331.5 DATES MAR 1 THRU APR 1

A = 16.00000000 B = -4.81250000

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	5934.7210	5937.8844	-1.3705	0.2681
1	5775.7704	5761.1486	6.3278	0.0
2	-0.0026	0.1050	0.0164	0.0041
3	-0.0004	-0.0539	-0.0775	-0.0022
4	0.0018	-0.0010	0.0015	-0.0039
5	0.0001	0.0017	0.0042	0.0004
SUMS	11710.4903	11699.0848	4.9019	0.2665

DAYS 92 THRU 123 JD 2444330.5 TO 2444362.5 DATES APR 1 THRU MAY 2

A = 16.00000000 B = -6.75000000

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	5965.2760	5940.0940	10.4524	0.2665
1	5775.7708	5760.9236	5.6317	-0.0019
2	-0.0026	-0.2005	-0.3682	-0.0026
3	-0.0014	-0.0321	-0.0650	0.0016
4	0.0018	0.0040	0.0010	0.0020
5	0.0008	-0.0043	0.0019	-0.0005
SUMS	11741.0454	11700.7847	15.6538	0.2651

DAYS 1 THRU 32 JD 2444239.5 TO 2444271.5 DATES JAN 1 THRU FEB 1

A = 16.00000000 B = -1.06250000

TERM	VENUS GHA	VENUS DEC	MARS GHA	MARS DEC	JUPITER GHA	JUPITER DEC	SATURN GHA	SATURN DEC
	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG
0	6261.9255	-12.5863	6427.6466	9.1416	6434.0461	9.1120	6417.5123	3.2737
1	5757.2124	7.3402	5775.7071	0.5371	5776.7548	0.4675	5776.0088	0.1830
2	0.6686	0.6781	1.5286	0.6155	0.3506	0.1366	0.2093	0.0866
3	-0.0595	-0.1592	0.0826	0.0149	-0.0254	-0.0106	-0.0030	-0.0027
4	-0.0116	0.0044	-0.0301	-0.0157	-0.0035	-0.0043	-0.0008	0.0002
5	-0.0023	0.0072	-0.0027	-0.0035	0.0026	-0.0012	-0.0018	-0.0013
SUMS	12019.7331	-4.7156	12204.9321	10.2899	12211.1252	9.7000	12193.7248	3.5395

DAYS 32 THRU 63 JD 2444270.5 TO 2444302.5 DATES FEB 1 THRU MAR 3

A = 16.00000000 B = -3.00000000

TERM	VENUS GHA	VENUS DEC	MARS GHA	MARS DEC	JUPITER GHA	JUPITER DEC	SATURN GHA	SATURN DEC
	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG
0	5898.4370	3.1275	6103.8814	12.2580	6107.5855	10.4061	6089.2509	3.9177
1	5758.8304	8.3552	5781.3304	2.3347	5777.7027	0.7897	5776.6992	0.4543
2	0.1426	-0.1375	0.8734	0.0733	0.0993	0.0196	0.1293	0.0486
3	-0.0784	-0.1329	-0.4177	-0.2101	-0.0631	-0.0187	-0.0165	-0.0066
4	0.0123	0.0009	-0.0644	-0.0104	-0.0024	-0.0007	-0.0010	-0.0025
5	-0.0004	-0.0001	0.0203	0.0130	0.0026	-0.0034	-0.0038	-0.0019
SUMS	11657.3435	11.2131	11885.6234	14.4585	11885.3246	11.1926	11866.0581	4.4096

DAYS 61 THRU 92 JD 2444299.5 TO 2444331.5 DATES MAR 1 THRU APR 1

A = 16.00000000 B = -4.81250000

TERM	VENUS GHA	VENUS DEC	MARS GHA	MARS DEC	JUPITER GHA	JUPITER DEC	SATURN GHA	SATURN DEC
	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG
0	5896.4277	17.0482	6142.6590	15.6126	6139.6309	11.7609	6119.8054	4.8286
1	5758.8247	6.6020	5780.0151	0.9130	5777.4659	0.6314	5776.9303	0.5119
2	-0.0392	-0.8074	-1.4134	-0.6566	-0.2187	-0.0997	-0.0069	-0.0168
3	0.0551	-0.1105	-0.2292	-0.0132	-0.0545	-0.0196	-0.0296	-0.0178
4	0.0368	0.0073	0.0872	0.0320	0.0037	0.0013	-0.0021	0.0002
5	0.0017	0.0023	0.0029	-0.0023	0.0042	0.0022	0.0021	0.0043
SUMS	11655.3068	22.7419	11921.1216	15.8855	11916.8315	12.2765	11896.6992	5.3104

DAYS 92 THRU 123 JD 2444330.5 TO 2444362.5 DATES APR 1 THRU MAY 2

A = 16.00000000 B = -6.75000000

TERM	VENUS GHA	VENUS DEC	MARS GHA	MARS DEC	JUPITER GHA	JUPITER DEC	SATURN GHA	SATURN DEC
	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG
0	5894.9237	26.1660	5815.5924	15.1220	5812.3691	12.5214	5792.3817	5.6733
1	5760.3804	2.5868	5774.0986	-1.2542	5776.2299	0.1278	5776.6064	0.3261
2	1.1763	-1.1440	-1.3191	-0.4280	-0.3777	-0.1420	-0.1467	-0.0719
3	0.4200	0.0099	0.1314	0.0405	-0.0064	0.0011	-0.0145	-0.0068
4	0.0625	0.0197	0.0120	-0.0038	0.0063	0.0002	0.0027	0.0003
5	-0.0048	0.0003	-0.0064	0.0006	-0.0008	-0.0010	-0.0014	0.0008
SUMS	11656.9581	27.6387	11588.5089	13.4771	11588.2204	12.5075	11568.8282	5.9218

DAYS 122 THRU 153 JD 2444360.5 TO 2444392.5 DATES MAY 1 THRU JUNE 1

A = 16.00000000 B = -8.62500000

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	5994.8445	5940.9194	19.3117	0.2642
1	5775.7697	5759.8833	3.6109	-0.0033
2	0.0002	-0.2964	-0.6979	0.0
3	0.0023	0.0278	-0.0503	0.0061
4	0.0001	0.0086	0.0026	0.0
5	-0.0019	-0.0063	-0.0004	-0.0037
SUMS	11770.6149	11700.5364	22.1766	0.2633

DAYS 153 THRU 184 JD 2444391.5 TO 2444423.5 DATES JUNE 1 THRU JULY 2

A = 16.00000000 B = -10.56250000

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	6025.3996	5939.8090	23.3780	0.2633
1	5775.7696	5759.1329	0.4695	0.0
2	0.0001	-0.0294	-0.8805	0.0
3	0.0026	0.0715	-0.0143	0.0
4	0.0001	-0.0032	0.0079	0.0
5	-0.0021	-0.0011	0.0064	0.0
SUMS	11801.1699	11698.9797	22.9670	0.2633

DAYS 183 THRU 214 JD 2444421.5 TO 2444453.5 DATES JULY 1 THRU AUG 1

A = 16.00000000 B = -12.43750000

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	6054.9694	5938.4865	21.2100	0.2633
1	5775.7708	5759.6542	-2.7073	0.0
2	-0.0036	0.2914	-0.7673	0.0
3	-0.0029	0.0328	0.0414	0.0
4	0.0031	-0.0166	0.0047	0.0
5	0.0027	0.0014	0.0005	0.0
SUMS	11830.7395	11698.4497	17.7820	0.2633

DAYS 214 THRU 245 JD 2444452.5 TO 2444484.5 DATES AUG 1 THRU SEPT 1

A = 16.00000000 B = -14.37500000

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	6085.5243	5938.9819	13.4436	0.2633
1	5775.7704	5760.8466	-5.1064	-0.0007
2	-0.0026	0.2818	-0.4553	0.0004
3	-0.0004	-0.0300	0.0616	0.0031
4	0.0018	-0.0121	0.0011	0.0006
5	0.0002	0.0016	-0.0019	-0.0015
SUMS	11861.2937	11700.0698	7.9427	0.2652

DAYS 122 THRU 153 JD 2444360.5 TO 2444392.5 DATES MAY 1 THRU JUNE 1

A = 16.00000000 B = -8.62500000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5903.2307	27.2792	5838.2597	11.4887	5841.4845	12.2694	5822.9180	6.0014
1	5770.6880	-1.1768	5770.4875	-2.5247	5774.8521	-0.3867	5775.9294	0.0137
2	4.7275	-0.8428	-0.6737	-0.2687	-0.3373	-0.1296	-0.2024	-0.0867
3	0.7928	0.0055	0.0792	0.0210	0.0176	0.0038	-0.0012	0.0002
4	-0.1035	-0.0352	-0.0041	-0.0035	0.0003	0.0034	0.0028	-0.0009
5	-0.0997	0.0005	0.0051	-0.0016	-0.0025	0.0010	-0.0016	0.0005
SUMS	11679.2358	25.2304	11608.1537	8.7112	11616.0147	11.7613	11598.6450	5.9282

DAYS 153 THRU 184 JD 2444391.5 TO 2444423.5 DATES JUNE 1 THRU JULY 2

A = 16.00000000 B = -10.56250000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5942.6269	21.7145	5856.5710	5.7067	5869.1172	11.0844	5853.0281	5.7031
1	5786.2395	-4.1522	5768.6115	-3.3862	5773.7387	-0.8153	5775.1606	-0.3143
2	-1.1635	0.1733	-0.3583	-0.1780	-0.2341	-0.0964	-0.1859	-0.0771
3	-2.7390	0.7797	0.0385	0.0233	0.0201	0.0052	0.0084	0.0030
4	0.2547	0.0355	-0.0009	0.0016	-0.0007	0.0020	0.0002	0.0005
5	0.3103	-0.1179	-0.0037	-0.0060	-0.0010	0.0005	-0.0012	0.0
SUMS	11725.5289	18.4329	11624.8581	2.1614	11642.6402	10.1804	11628.0102	5.3152

DAYS 183 THRU 214 JD 2444421.5 TO 2444453.5 DATES JULY 1 THRU AUG 1

A = 16.00000000 B = -12.43750000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5977.6505	17.8660	5871.6246	-1.1508	5894.1728	9.2603	5880.8528	4.8652
1	5769.9726	0.3858	5767.4888	-3.8686	5773.0458	-1.1096	5774.5465	-0.5661
2	-3.8847	0.8855	-0.2753	-0.0775	-0.1398	-0.0639	-0.1377	-0.0558
3	0.6487	-0.3734	0.0032	0.0148	0.0140	0.0001	0.0168	0.0082
4	-0.0152	-0.0155	-0.0015	-0.0027	0.0006	-0.0002	0.0005	0.0008
5	-0.0411	0.0270	0.0006	0.0024	0.0022	0.0038	-0.0044	-0.0036
SUMS	11744.3308	18.7754	11638.8404	-5.0824	11667.0956	8.0905	11655.2745	4.2487

DAYS 214 THRU 245 JD 2444452.5 TO 2444484.5 DATES AUG 1 THRU SEPT 1

A = 16.00000000 B = -14.37500000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5986.2870	19.5145	5885.0945	-8.8052	5919.0341	6.9066	5908.5991	3.5947
1	5760.5694	0.2945	5766.3918	-3.9510	5772.6669	-1.2977	5774.1328	-0.7286
2	-1.3341	-0.6969	-0.3042	0.0445	-0.0585	-0.0304	-0.0777	-0.0271
3	0.2669	-0.1567	-0.0070	0.0262	0.0163	0.0074	0.0033	0.0054
4	-0.0307	0.0268	-0.0015	0.0008	-0.0015	-0.0016	0.0004	-0.0011
5	0.0082	0.0006	-0.0019	-0.0018	-0.0029	-0.0017	0.0060	-0.0002
SUMS	11745.7667	18.9828	11651.1717	-12.6865	11691.6544	5.5826	11682.6639	2.8431

DAYS 245 THRU 276 JD 2444483.5 TO 2444515.5 DATES SEPT 1 THRU OCT 2

A = 16.00000000 B = -16.31250000

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	6116.0794	5941.3560	2.2827	0.2651
1	5775.7708	5761.4253	-6.1868	0.0019
2	-0.0026	0.0093	-0.0953	0.0026
3	-0.0014	-0.0619	0.0716	-0.0016
4	0.0018	-0.0084	-0.0008	-0.0020
5	0.0008	0.0033	-0.0052	0.0005
SUMS	11891.8488	11702.7236	-3.9338	0.2665

DAYS 275 THRU 306 JD 2444513.5 TO 2444545.5 DATES OCT 1 THRU NOV 1

A = 16.00000000 B = -18.18750000

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	6145.6479	5943.6412	-9.2273	0.2675
1	5775.7697	5760.8174	-5.8549	0.0033
2	0.0002	-0.3052	0.2816	0.0
3	0.0023	-0.0558	0.0649	-0.0061
4	0.0002	-0.0039	0.0025	0.0
5	-0.0019	0.0059	0.0067	0.0037
SUMS	11921.4184	11704.0996	-14.7265	0.2684

DAYS 306 THRU 337 JD 2444544.5 TO 2444576.5 DATES NOV 1 THRU DEC 2

A = 16.00000000 B = -20.12500000

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	5816.2029	5943.7592	-18.9684	0.2701
1	5775.7697	5759.2200	-3.9122	-0.0007
2	0.0003	-0.4400	0.7237	-0.0004
3	0.0024	0.0122	0.0721	0.0031
4	0.0001	0.0098	-0.0047	-0.0006
5	-0.0020	0.0023	-0.0009	-0.0015
SUMS	11591.9734	11702.5635	-22.0904	0.2700

DAYS 335 THRU 366 JD 2444573.5 TO 2444605.5 DATES NOV 30 THRU DEC 31

A = 16.00000000 B = -21.93750000

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	5844.7869	5941.1098	-23.3126	0.2717
1	5775.7702	5758.0576	-0.7148	-0.0007
2	0.0006	-0.1087	0.9931	-0.0004
3	0.0009	0.0985	0.0200	0.0031
4	-0.0008	-0.0038	-0.0095	-0.0006
5	-0.0009	-0.0059	-0.0011	-0.0015
SUMS	11620.5569	11699.1475	-23.0249	0.2716

DAYS 245 THRU 276 JD 2444483.5 TO 2444515.5 DATES SEPT 1 THRU OCT 2

A = 16.00000000 B = -16.31250000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5984.0602	16.7136	5896.2534	-16.1004	5943.4448	4.3143	5935.7641	2.1123
1	5757.8952	-3.3896	5765.0815	-3.4735	5772.5765	-1.3575	5773.9503	-0.7838
2	-0.1709	-1.0184	-0.3656	0.2107	0.0096	0.0025	-0.0135	0.0011
3	0.1186	0.0343	-0.0018	0.0393	0.0042	0.0094	0.0130	0.0081
4	-0.0250	0.0148	0.0002	0.0014	0.0016	-0.0003	-0.0010	-0.0014
5	0.0002	-0.0050	-0.0030	-0.0059	0.0069	-0.0028	-0.0014	-0.0036
SUMS	11741.8783	12.3497	11660.9647	-19.3284	11716.0436	2.9656	11709.7115	1.3327

DAYS 275 THRU 306 JD 2444513.5 TO 2444545.5 DATES OCT 1 THRU NOV 1

A = 16.00000000 B = -18.18750000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5980.0215	7.1625	5904.4645	-21.6476	5967.1426	1.8194	5961.9450	0.6768
1	5757.9447	-6.5018	5763.6770	-2.3233	5772.7475	-1.2822	5774.0161	-0.7288
2	0.0530	-0.5561	-0.3575	0.4050	0.0831	0.0409	0.0457	0.0294
3	-0.0480	0.1135	0.0148	0.0288	0.0177	0.0139	0.0034	0.0021
4	-0.0151	0.0029	0.0029	-0.0030	0.0007	-0.0014	0.0033	-0.0007
5	0.0101	0.0006	0.0017	0.0035	-0.0036	-0.0056	0.0066	0.0018
SUMS	11737.9662	0.2216	11667.8034	-23.5366	11739.9880	0.5850	11736.0201	-0.0194

DAYS 306 THRU 337 JD 2444544.5 TO 2444576.5 DATES NOV 1 THRU DEC 2

A = 16.00000000 B = -20.12500000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5975.8123	-6.6219	5910.4041	-24.4122	5992.2626	-0.4600	5989.3683	-0.5912
1	5757.4421	-7.2248	5762.5678	-0.4250	5773.2428	-1.0443	5774.3401	-0.5579
2	-0.3626	0.2135	-0.1798	0.5584	0.1758	0.0805	0.1218	0.0609
3	-0.0886	0.1405	0.0482	0.0096	0.0159	0.0113	0.0149	0.0016
4	0.0042	0.0026	0.0022	-0.0025	0.0001	0.0029	-0.0023	-0.0020
5	0.0024	0.0041	-0.0027	0.0048	0.0010	-0.0035	-0.0027	0.0019
SUMS	11732.8098	-13.4860	11672.8398	-24.2669	11765.6982	-1.4131	11763.8401	-1.0867

DAYS 335 THRU 366 JD 2444573.5 TO 2444605.5 DATES NOV 30 THRU DEC 31

A = 16.00000000 B = -21.93750000

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5969.5467	-18.1327	5914.7476	-23.2932	6016.9503	-2.0326	6015.8236	-1.3836
1	5755.4770	-4.9836	5762.3797	1.6671	5774.0614	-0.6658	5774.8892	-0.3028
2	-0.6203	1.0252	0.0818	0.5688	0.2756	0.1248	0.1806	0.0826
3	0.0222	0.1407	0.0508	-0.0111	0.0193	0.0060	0.0071	0.0052
4	0.0199	-0.0105	-0.0069	-0.0045	0.0015	-0.0001	-0.0009	-0.0012
5	-0.0032	-0.0015	-0.0065	-0.0022	-0.0004	0.0015	0.0018	-0.0014
SUMS	11724.4423	-21.9624	11677.2465	-21.0751	11791.3077	-2.5662	11790.9014	-1.6012

DAYS 1 THRU 6 JD 2444239.5 TO 2444245.5 DATES JAN 1 THRU JAN 6

A = 3.00000000 B = -1.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1419.4231	17.3977	0.9237	0.2517
1	1044.1274	-5.2880	-0.0239	-0.0065
2	2.2017	-3.5912	0.0034	0.0009
3	0.2601	0.6731	0.0024	0.0007
4	-0.2444	0.0852	-0.0001	0.0
5	-0.0130	-0.0470	-0.0011	-0.0003
SUMS	2465.7549	9.2298	0.9044	0.2465

DAYS 7 THRU 12 JD 2444245.5 TO 2444251.5 DATES JAN 7 THRU JAN 12

A = 3.00000000 B = -3.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1354.8672	-2.0336	0.9067	0.2470
1	1049.1679	-11.6293	0.0134	0.0036
2	-0.7572	0.1794	0.0140	0.0038
3	-0.8426	0.5621	0.0028	0.0008
4	-0.0023	0.0356	-0.0015	-0.0004
5	0.0273	0.0192	-0.0022	-0.0006
SUMS	2402.4603	-12.8666	0.9332	0.2542

DAYS 13 THRU 18 JD 2444251.5 TO 2444257.5 DATES JAN 13 THRU JAN 18

A = 3.00000000 B = -5.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1284.5047	-18.9532	0.9742	0.2654
1	1039.0235	-1.8762	0.0417	0.0114
2	-2.3849	5.0735	-0.0048	-0.0013
3	1.0351	0.6699	-0.0089	-0.0024
4	0.3052	-0.2840	-0.0008	-0.0002
5	-0.0948	-0.0905	0.0024	0.0007
SUMS	2322.3888	-15.4605	1.0038	0.2736

DAYS 19 THRU 24 JD 2444257.5 TO 2444263.5 DATES JAN 19 THRU JAN 24

A = 3.00000000 B = -7.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1202.2304	-3.3948	0.9993	0.2723
1	1041.6472	14.0403	-0.0190	-0.0052
2	1.4980	0.5790	-0.0101	-0.0027
3	-0.5459	-1.3542	0.0043	0.0012
4	-0.1534	0.0768	-0.0005	-0.0001
5	0.0851	0.0348	-0.0004	-0.0001
SUMS	2244.7614	9.9819	0.9736	0.2654

DAYS 25 THRU 30 JD 2444263.5 TO 2444269.5 DATES JAN 25 THRU JAN 30

A = 3.00000000 B = -9.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1127.2002	18.1316	0.9451	0.2575
1	1042.1549	4.1402	-0.0254	-0.0069
2	0.0466	-4.3888	0.0019	0.0005
3	0.5257	-0.1882	-0.0031	-0.0008
4	0.1354	0.1955	0.0	0.0
5	-0.0604	0.0047	0.0027	0.0007
SUMS	2170.0024	17.8950	0.9212	0.2510

DAYS 31 THRU 36 JD 2444269.5 TO 2444275.5 DATES JAN 31 THRU FEB 5

A = 3.00000000 B = -11.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1415.9829	10.3667	0.9049	0.2466
1	1047.8536	-9.9748	-0.0128	-0.0035
2	1.6308	-1.7566	0.0091	0.0025
3	-0.4053	0.6844	0.0076	0.0021
4	-0.1448	-0.0206	-0.0027	-0.0007
5	0.0190	-0.0150	-0.0047	-0.0013
SUMS	2464.9362	-0.7159	0.9014	0.2457

DAYS 37 THRU 42 JD 2444275.5 TO 2444281.5 DATES FEB 6 THRU FEB 11

A = 3.00000000 B = -13.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1353.3972	-11.6370	0.9205	0.2508
1	1046.7398	-9.6437	0.0302	0.0082
2	-2.4364	1.9544	0.0119	0.0032
3	-0.6342	0.7453	0.0013	0.0004
4	0.1293	0.0676	-0.0015	-0.0004
5	0.0486	-0.0012	-0.0023	-0.0006
SUMS	2397.2443	-18.5146	0.9601	0.2616

DAYS 43 THRU 48 JD 2444281.5 TO 2444287.5 DATES FEB 12 THRU FEB 17

A = 3.00000000 B = -15.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1275.8218	-16.6559	1.0045	0.2737
1	1037.4810	7.2232	0.0332	0.0091
2	0.0732	5.1911	-0.0167	-0.0045
3	1.1250	-0.6127	-0.0053	-0.0014
4	-0.1667	-0.4155	0.0012	0.0003
5	-0.1225	0.0259	0.0013	0.0003
SUMS	2314.2118	-5.2439	1.0182	0.2775

DAYS 49 THRU 54 JD 2444287.5 TO 2444293.5 DATES FEB 18 THRU FEB 23

A = 3.00000000 B = -17.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1195.1174	8.8135	0.9903	0.2698
1	1041.6343	12.4655	-0.0397	-0.0108
2	0.3417	-2.7740	-0.0069	-0.0019
3	-0.3183	-0.9794	0.0092	0.0025
4	0.1161	0.2112	0.0005	0.0001
5	0.0454	0.0066	-0.0034	-0.0009
SUMS	2236.9366	17.7434	0.9500	0.2588

DAYS 55 THRU 60 JD 2444293.5 TO 2444299.5 DATES FEB 24 THRU FEB 29

A = 3.00000000 B = -19.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1119.8316	18.2085	0.9199	0.2536
1	1044.1852	-3.7086	-0.0235	-0.0064
2	1.6623	-3.8144	0.0090	0.0024
3	0.2766	0.4851	-0.0005	-0.0001
4	-0.1253	0.1031	-0.0019	-0.0005
5	-0.0291	-0.0232	0.0010	0.0003
SUMS	2165.8013	11.2505	0.9040	0.2463

DAYS 61 THRU 66 JD 2444299.5 TO 2444305.5 DATES MAR 1 THRU MAR 6

A = 3.00000000 B = -21.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1414.6136	0.3330	0.8998	0.2452
1	1049.4067	-11.6069	0.0005	0.0001
2	0.0232	-0.0678	0.0075	0.0021
3	-0.6181	0.6061	0.0076	0.0021
4	-0.0312	-0.0066	0.0	0.0
5	0.0156	0.0100	-0.0042	-0.0012
SUMS	2463.4098	-10.7322	0.9112	0.2483

DAYS 67 THRU 72 JD 2444305.5 TO 2444311.5 DATES MAR 7 THRU MAR 12

A = 3.00000000 B = -23.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1348.6597	-18.1208	0.9422	0.2567
1	1042.6435	-4.1331	0.0404	0.0110
2	-2.6931	4.0164	0.0084	0.0023
3	0.1468	0.7450	-0.0019	-0.0005
4	0.2464	-0.0723	-0.0006	-0.0002
5	0.0122	-0.0572	0.0002	0.0001
SUMS	2389.0155	-17.6220	0.9887	0.2694

DAYS 73 THRU 78 JD 2444311.5 TO 2444317.5 DATES MAR 13 THRU MAR 18

A = 3.00000000 B = -25.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1267.6310	-7.4343	1.0219	0.2784
1	1039.0524	13.8630	0.0133	0.0036
2	0.7105	2.3704	-0.0253	-0.0069
3	0.0418	-1.5667	0.0010	0.0003
4	-0.1893	-0.1731	0.0035	0.0010
5	0.0437	0.0888	-0.0025	-0.0007
SUMS	2307.2901	7.1481	1.0119	0.2757

DAYS 79 THRU 84 JD 2444317.5 TO 2444323.5 DATES MAR 19 THRU MAR 24

A = 3.00000000 B = -27.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1187.5998	17.3096	0.9683	0.2638
1	1040.7373	5.9044	-0.0488	-0.0133
2	0.7763	-4.7111	0.0020	0.0005
3	0.4655	-0.1710	0.0101	0.0028
4	0.0668	0.2602	-0.0011	-0.0003
5	-0.0503	-0.0233	-0.0038	-0.0010
SUMS	2229.5954	18.5688	0.9267	0.2525

DAYS 85 THRU 90 JD 2444323.5 TO 2444329.5 DATES MAR 25 THRU MAR 30

A = 3.00000000 B = -29.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1115.3271	12.0705	0.9047	0.2465
1	1047.6316	-9.2569	-0.0142	-0.0039
2	1.6147	-2.1349	0.0079	0.0022
3	-0.4025	0.6258	0.0051	0.0014
4	-0.0956	-0.0019	0.0007	0.0002
5	0.0224	-0.0033	-0.0041	-0.0011
SUMS	2164.0977	1.2993	0.9001	0.2453

DAYS 91 THRU 96 JD 2444329.5 TO 2444335.5 DATES MAR 31 THRU APR 5

A = 3.00000000 B = -31.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1412.9510	-10.0011	0.9080	0.2474
1	1047.7635	-10.2841	0.0120	0.0033
2	-1.6136	1.6936	0.0088	0.0024
3	-0.4636	0.6924	0.0113	0.0031
4	0.0873	0.0131	-0.0015	-0.0004
5	0.0271	-0.0025	-0.0081	-0.0022
SUMS	2458.7517	-17.8886	0.9305	0.2536

DAYS 97 THRU 102 JD 2444335.5 TO 2444341.5 DATES APR 6 THRU APR 11

A = 3.00000000 B = -33.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1340.4866	-18.3304	0.9673	0.2636
1	1040.3327	4.2865	0.0426	0.0116
2	-0.8195	4.9167	0.0036	0.0010
3	0.6110	-0.0422	-0.0048	-0.0013
4	-0.0403	-0.2555	-0.0025	-0.0007
5	-0.0684	-0.0244	0.0002	0.0001
SUMS	2380.5021	-9.4493	1.0064	0.2743

DAYS 103 THRU 108 JD 2444341.5 TO 2444347.5 DATES APR 12 THRU APR 17

A = 3.00000000 B = -35.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1260.5167	5.0325	1.0189	0.2776
1	1039.7469	14.5477	-0.0131	-0.0036
2	-0.4936	-1.5602	-0.0236	-0.0064
3	-0.1430	-1.6036	0.0055	0.0015
4	0.1449	0.1057	0.0023	0.0006
5	0.0615	0.0825	-0.0016	-0.0004
SUMS	2299.8334	16.6046	0.9884	0.2693

DAYS 109 THRU 114 JD 2444347.5 TO 2444353.5 DATES APR 18 THRU APR 23

A = 3.00000000 B = -37.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1180.2146	19.0493	0.9421	0.2567
1	1042.2787	-2.3530	-0.0431	-0.0117
2	2.4367	-4.3453	0.0050	0.0014
3	0.3345	0.6280	0.0078	0.0021
4	-0.2260	0.1166	0.0020	0.0005
5	-0.0205	-0.0592	-0.0043	-0.0012
SUMS	2225.0180	13.0364	0.9095	0.2478

DAYS 115 THRU 120 JD 2444353.5 TO 2444359.5 DATES APR 24 THRU APR 29

A = 3.00000000 B = -39.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1113.6362	2.4007	0.9009	0.2455
1	1049.4294	-11.6972	0.0038	0.0010
2	0.1525	-0.4732	0.0075	0.0020
3	-0.6706	0.5899	-0.0088	-0.0024
4	0.0070	0.0147	0.0011	0.0003
5	0.0182	0.0131	0.0050	0.0014
SUMS	2162.5727	-9.1520	0.9095	0.2478

DAYS 121 THRU 126 JD 2444359.5 TO 2444365.5 DATES APR 30 THRU MAY 5

A = 3.00000000 B = -41.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1408.4306	-17.6582	0.9286	0.2530
1	1043.7264	-5.4997	0.0242	0.0066
2	-2.0834	3.7420	0.0061	0.0017
3	0.2479	0.6741	0.0005	0.0001
4	0.1918	-0.0992	-0.0018	-0.0005
5	-0.0069	-0.0386	-0.0014	-0.0004
SUMS	2450.5064	-18.8796	0.9562	0.2605

DAYS 127 THRU 132 JD 2444365.5 TO 2444371.5 DATES MAY 6 THRU MAY 11

A = 3.00000000 B = -43.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1331.5787	-10.9743	0.9879	0.2692
1	1041.4002	11.8560	0.0311	0.0085
2	0.3492	3.1946	-0.0058	-0.0016
3	-0.2008	-0.9569	-0.0081	-0.0022
4	-0.1876	-0.1881	0.0007	0.0002
5	0.0361	0.0135	0.0029	0.0008
SUMS	2372.9758	2.9448	1.0087	0.2749

DAYS 133 THRU 138 JD 2444371.5 TO 2444377.5 DATES MAY 12 THRU MAY 17

A = 3.00000000 B = -45.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1252.8093	15.5128	0.9964	0.2715
1	1038.8186	9.0831	-0.0308	-0.0084
2	-0.5698	-4.6292	-0.0159	-0.0043
3	0.7613	-0.8574	0.0071	0.0019
4	0.2497	0.3385	0.0018	0.0005
5	-0.0679	0.0512	-0.0022	-0.0006
SUMS	2292.0012	19.4990	0.9564	0.2606

DAYS 139 THRU 144 JD 2444377.5 TO 2444383.5 DATES MAY 18 THRU MAY 23

A = 3.00000000 B = -47.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1175.3337	14.1995	0.9192	0.2505
1	1046.1435	-8.6296	-0.0282	-0.0077
2	2.5800	-2.5415	0.0101	0.0028
3	-0.4765	0.7612	-0.0010	-0.0003
4	-0.1918	-0.0465	0.0006	0.0002
5	0.0542	-0.0175	0.0026	0.0007
SUMS	2223.4431	3.7256	0.9033	0.2462

DAYS 145 THRU 150 JD 2444383.5 TO 2444389.5 DATES MAY 24 THRU MAY 29

A = 3.00000000 B = -49.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1112.5648	-8.0069	0.9100	0.2479
1	1048.1324	-11.1724	0.0155	0.0042
2	-1.6666	1.2213	0.0092	0.0025
3	-0.5945	0.7126	0.0006	0.0002
4	0.1137	0.0528	-0.0018	-0.0005
5	0.0309	0.0007	-0.0023	-0.0006
SUMS	2158.5807	-17.1919	0.9312	0.2537

DAYS 151 THRU 156 JD 2444389.5 TO 2444395.5 DATES MAY 30 THRU JUNE 4

A = 3.00000000 B = -51.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1400.3377	-19.3077	0.9568	0.2607
1	1040.6047	2.6062	0.0232	0.0063
2	-0.2961	4.9202	-0.0025	-0.0007
3	0.8742	-0.0691	0.0048	0.0013
4	-0.0824	-0.2648	0.0011	0.0003
5	-0.1006	0.0030	-0.0048	-0.0013
SUMS	2441.3375	-12.1122	0.9786	0.2666

DAYS 157 THRU 162 JD 2444395.5 TO 2444401.5 DATES JUNE 5 THRU JUNE 10

A = 3.00000000 B = -53.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1323.7223	1.2859	0.9932	0.2706
1	1042.3912	14.4426	0.0091	0.0025
2	-0.6278	-0.1793	-0.0070	-0.0019
3	-0.6400	-1.2867	-0.0033	-0.0009
4	0.0708	-0.0401	-0.0015	-0.0004
5	0.0754	0.0220	0.0001	0.0
SUMS	2364.9919	14.2444	0.9906	0.2699

DAYS 163 THRU 168 JD 2444401.5 TO 2444407.5 DATES JUNE 11 THRU JUNE 16

A = 3.00000000 B = -55.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1244.2784	19.6818	0.9633	0.2625
1	1039.7025	0.2898	-0.0342	-0.0093
2	1.5308	-5.1597	-0.0036	-0.0010
3	1.0864	0.3427	0.0004	0.0001
4	-0.1496	0.3027	-0.0001	0.0
5	-0.1208	-0.0526	0.0029	0.0008
SUMS	2286.3277	15.4047	0.9287	0.2531

DAYS 169 THRU 174 JD 2444407.5 TO 2444413.5 DATES JUNE 17 THRU JUNE 22

A = 3.00000000 B = -57.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1173.6042	5.2002	0.9067	0.2470
1	1049.0626	-11.6149	-0.0108	-0.0029
2	1.0437	-0.7643	0.0122	0.0033
3	-0.8179	0.5894	0.0026	0.0007
4	-0.0447	-0.0395	-0.0005	-0.0001
5	0.0304	0.0171	-0.0016	-0.0004
SUMS	2222.8783	-6.6120	0.9086	0.2476

DAYS 175 THRU 180 JD 2444413.5 TO 2444419.5 DATES JUNE 23 THRU JUNE 28

A = 3.00000000 B = -59.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1109.4769	-16.3825	0.9322	0.2540
1	1044.0630	-7.3096	0.0313	0.0085
2	-2.7885	3.3184	0.0033	0.0009
3	0.0190	0.8807	-0.0095	-0.0026
4	0.3030	-0.0348	-0.0002	0.0
5	0.0304	-0.0589	0.0057	0.0015
SUMS	2151.1038	-19.5867	0.9628	0.2623

DAYS 181 THRU 186 JD 2444419.5 TO 2444425.5 DATES JUNE 29 THRU JULY 4

A = 3.00000000 B = -61.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1391.1684	-13.1457	0.9834	0.2679
1	1041.0153	10.7819	0.0118	0.0032
2	1.3714	3.5097	-0.0083	-0.0023
3	0.0824	-1.0427	0.0023	0.0006
4	-0.3165	-0.1541	0.0	0.0
5	0.0230	0.0571	-0.0008	-0.0002
SUMS	2433.3440	0.0062	0.9884	0.2692

DAYS 187 THRU 192 JD 2444425.5 TO 2444431.5 DATES JULY 5 THRU JULY 10

A = 3.00000000 B = -63.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1315.6456	13.1208	0.9809	0.2673
1	1041.2327	10.7363	-0.0121	-0.0033
2	-1.3253	-3.4800	-0.0057	-0.0016
3	0.0321	-0.9998	-0.0035	-0.0009
4	0.3098	0.1465	-0.0006	-0.0002
5	0.0191	0.0444	0.0018	0.0005
SUMS	2355.9140	19.5682	0.9608	0.2618

DAYS 193 THRU 198 JD 2444431.5 TO 2444437.5 DATES JULY 11 THRU JULY 16

A = 3.00000000 B = -65.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1237.5233	16.4199	0.9328	0.2541
1	1043.9374	-7.2853	-0.0288	-0.0078
2	2.7232	-3.3614	0.0006	0.0002
3	0.0794	0.8753	0.0017	0.0005
4	-0.2966	0.0440	0.0022	0.0006
5	0.0202	-0.0560	0.0014	0.0004
SUMS	2283.9869	6.6365	0.9099	0.2480

DAYS 199 THRU 204 JD 2444437.5 TO 2444443.5 DATES JULY 17 THRU JULY 22

A = 3.00000000 B = -67.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1173.2505	-5.1796	0.9056	0.2467
1	1049.1577	-11.5857	0.0089	0.0024
2	-0.9309	0.7927	0.0118	0.0032
3	-0.8204	0.5698	0.0015	0.0004
4	0.0363	0.0319	0.0006	0.0002
5	0.0310	0.0243	-0.0020	-0.0006
SUMS	2220.7242	-15.3466	0.9264	0.2523

DAYS 205 THRU 210 JD 2444443.5 TO 2444449.5 DATES JULY 23 THRU JULY 28

A = 3.00000000 B = -69.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1103.0381	-19.6686	0.9626	0.2623
1	1039.8599	0.1851	0.0401	0.0109
2	-1.7194	5.1289	-0.0011	-0.0003
3	1.0227	0.3950	-0.0116	-0.0032
4	0.1799	-0.2888	-0.0022	-0.0006
5	-0.1097	-0.0619	0.0052	0.0014
SUMS	2142.2715	-14.3103	0.9930	0.2705

DAYS 211 THRU 216 JD 2444449.5 TO 2444455.5 DATES JULY 29 THRU AUG 3

A = 3.00000000 B = -71.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1383.2179	-1.2653	0.9974	0.2718
1	1042.0684	14.5702	-0.0083	-0.0023
2	0.6830	0.1669	-0.0116	-0.0031
3	-0.5973	-1.3442	0.0016	0.0004
4	-0.0820	0.0452	0.0007	0.0002
5	0.0778	0.0303	0.0006	0.0002
SUMS	2425.3678	12.2031	0.9804	0.2672

DAYS 217 THRU 222 JD 2444455.5 TO 2444461.5 DATES AUG 4 THRU AUG 9

A = 3.00000000 B = -73.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1306.3721	19.3347	0.9564	0.2606
1	1040.7055	2.5168	-0.0255	-0.0069
2	0.3541	-4.9165	-0.0018	-0.0005
3	0.8201	-0.0488	0.0020	0.0005
4	0.0769	0.2540	0.0013	0.0004
5	-0.0914	0.0013	-0.0013	-0.0004
SUMS	2348.2373	17.1415	0.9311	0.2537

DAYS 223 THRU 228 JD 2444461.5 TO 2444467.5 DATES AUG 10 THRU AUG 15

A = 3.00000000 B = -75.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1234.2814	7.8808	0.9103	0.2480
1	1048.1291	-11.2511	-0.0159	-0.0043
2	1.6576	-1.2145	0.0062	0.0017
3	-0.5800	0.7279	0.0022	0.0006
4	-0.1143	-0.0503	-0.0002	-0.0001
5	0.0383	-0.0012	-0.0011	-0.0003
SUMS	2283.4121	-3.9084	0.9015	0.2456

DAYS 229 THRU 234 JD 2444467.5 TO 2444473.5 DATES AUG 16 THRU AUG 21

A = 3.00000000 B = -77.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1171.6643	-14.3480	0.9154	0.2494
1	1046.3967	-8.5588	0.0271	0.0074
2	-2.4593	2.5564	0.0136	0.0037
3	-0.4734	0.7350	-0.0013	-0.0004
4	0.1772	0.0436	-0.0019	-0.0005
5	0.0475	-0.0162	-0.0004	-0.0001
SUMS	2215.3530	-19.5880	0.9525	0.2595

DAYS 235 THRU 240 JD 2444473.5 TO 2444479.5 DATES AUG 22 THRU AUG 27

A = 3.00000000 B = -79.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1094.8396	-15.6192	0.9950	0.2711
1	1038.9219	9.0832	0.0345	0.0094
2	0.3244	4.7082	-0.0121	-0.0033
3	0.7352	-0.7878	-0.0029	-0.0008
4	-0.2196	-0.3478	0.0005	0.0001
5	-0.0645	0.0350	-0.0016	-0.0004
SUMS	2134.5370	-2.9284	1.0134	0.2761

DAYS 241 THRU 246 JD 2444479.5 TO 2444485.5 DATES AUG 28 THRU SEPT 2

A = 3.00000000 B = -81.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1375.4958	11.2423	0.9928	0.2705
1	1040.9157	12.0253	-0.0332	-0.0091
2	-0.3271	-3.3490	-0.0064	-0.0017
3	-0.1269	-1.0131	0.0075	0.0020
4	0.1886	0.2139	-0.0010	-0.0003
5	0.0291	0.0226	-0.0011	-0.0003
SUMS	2416.1752	19.1420	0.9586	0.2611

DAYS 247 THRU 252 JD 2444485.5 TO 2444491.5 DATES SEPT 3 THRU SEPT 8

A = 3.00000000 B = -83.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1298.1861	17.6735	0.9284	0.2530
1	1043.8143	-5.7747	-0.0240	-0.0065
2	2.1883	-3.7372	0.0074	0.0020
3	0.1927	0.6918	-0.0012	-0.0003
4	-0.1960	0.0885	-0.0024	-0.0006
5	-0.0023	-0.0338	0.0005	0.0001
SUMS	2344.1831	8.9081	0.9087	0.2477

DAYS 253 THRU 258 JD 2444491.5 TO 2444497.5 DATES SEPT 9 THRU SEPT 14

A = 3.00000000 B = -85.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1233.2216	-2.8459	0.8996	0.2451
1	1049.4983	-11.8527	-0.0023	-0.0006
2	-0.1766	0.5340	0.0092	0.0025
3	-0.6511	0.6046	-0.0001	0.0
4	0.0017	-0.0142	-0.0009	-0.0002
5	0.0161	0.0137	0.0017	0.0005
SUMS	2281.9100	-13.5605	0.9072	0.2473

DAYS 259 THRU 264 JD 2444497.5 TO 2444503.5 DATES SEPT 15 THRU SEPT 20

A = 3.00000000 B = -87.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1166.9237	-19.4837	0.9365	0.2552
1	1042.6234	-2.2051	0.0402	0.0110
2	-2.2933	4.3726	0.0105	0.0029
3	0.3188	0.5937	-0.0019	-0.0005
4	0.2018	-0.1130	-0.0023	-0.0006
5	-0.0197	-0.0526	-0.0007	-0.0002
SUMS	2207.7547	-16.8881	0.9823	0.2678

DAYS 265 THRU 270 JD 2444503.5 TO 2444509.5 DATES SEPT 21 THRU SEPT 26

A = 3.00000000 B = -89.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1087.4011	-5.0896	1.0195	0.2778
1	1039.8479	14.8995	0.0163	0.0044
2	0.2019	1.7149	-0.0270	-0.0073
3	-0.1792	-1.6107	0.0011	0.0003
4	-0.1242	-0.1469	0.0059	0.0016
5	0.0575	0.0774	-0.0022	-0.0006
SUMS	2127.2050	9.8446	1.0136	0.2762

DAYS 271 THRU 276 JD 2444509.5 TO 2444515.5 DATES SEPT 27 THRU OCT 2

A = 3.00000000 B = -91.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1366.5451	18.9618	0.9733	0.2652
1	1039.6291	4.2320	-0.0457	-0.0125
2	0.9417	-5.2237	0.0	0.0
3	0.7602	-0.0114	0.0052	0.0014
4	0.0218	0.2962	-0.0001	0.0
5	-0.0866	-0.0325	0.0009	0.0002
SUMS	2407.8113	18.2224	0.9336	0.2543

DAYS 277 THRU 282 JD 2444515.5 TO 2444521.5 DATES OCT 3 THRU OCT 8

A = 3.00000000 B = -93.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1293.6616	9.8522	0.9090	0.2477
1	1047.9617	-10.7513	-0.0168	-0.0046
2	1.6807	-1.6530	0.0070	0.0019
3	-0.5320	0.7073	-0.0010	-0.0003
4	-0.0753	-0.0226	-0.0002	-0.0001
5	0.0261	-0.0010	0.0004	0.0001
SUMS	2342.7228	-1.8684	0.8984	0.2447

DAYS 283 THRU 288 JD 2444521.5 TO 2444527.5 DATES OCT 9 THRU OCT 14

A = 3.00000000 B = -95.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1231.5736	-12.9231	0.9034	0.2461
1	1047.6286	-9.4352	0.0126	0.0034
2	-1.6744	2.2709	0.0076	0.0021
3	-0.3629	0.6516	-0.0014	-0.0004
4	0.1085	-0.0049	-0.0004	-0.0001
5	0.0201	-0.0058	0.0011	0.0003
SUMS	2277.2935	-19.4465	0.9229	0.2514

DAYS 289 THRU 294 JD 2444527.5 TO 2444533.5 DATES OCT 15 THRU OCT 20

A = 3.00000000 B = -97.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1159.5247	-17.9277	0.9617	0.2620
1	1041.1971	6.2500	0.0479	0.0130
2	-0.5602	4.7620	0.0042	0.0012
3	0.4210	-0.1910	-0.0123	-0.0033
4	-0.1038	-0.2433	-0.0009	-0.0002
5	-0.0513	-0.0214	0.0061	0.0017
SUMS	2200.4275	-7.3714	1.0067	0.2744

DAYS 295 THRU 300 JD 2444533.5 TO 2444539.5 DATES OCT 21 THRU OCT 26

A = 3.00000000 B = -99.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1080.4531	7.8077	1.0237	0.2789
1	1039.0376	14.5601	-0.0076	-0.0021
2	-1.1968	-2.3526	-0.0260	-0.0071
3	-0.0206	-1.7035	0.0007	0.0002
4	0.2489	0.1381	0.0033	0.0009
5	0.0591	0.1083	0.0011	0.0003
SUMS	2118.5813	18.5581	0.9952	0.2711

DAYS 301 THRU 306 JD 2444539.5 TO 2444545.5 DATES OCT 27 THRU NOV 1

A = 3.00000000 B = -101.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1358.0992	18.9190	0.9473	0.2581
1	1042.0399	-4.6152	-0.0441	-0.0120
2	3.0589	-4.2670	0.0060	0.0016
3	0.2116	0.8528	0.0010	0.0003
4	-0.3135	0.0808	0.0007	0.0002
5	0.0138	-0.0629	0.0019	0.0005
SUMS	2403.1099	10.9075	0.9128	0.2487

DAYS 307 THRU 312 JD 2444545.5 TO 2444551.5 DATES NOV 2 THRU NOV 7

A = 3.00000000 B = -103.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1292.1218	-0.7840	0.9000	0.2452
1	1049.6730	-12.1772	-0.0028	-0.0008
2	-0.0506	0.1316	0.0084	0.0023
3	-0.6869	0.6153	-0.0071	-0.0019
4	0.0403	0.0086	-0.0002	-0.0001
5	0.0152	0.0093	0.0055	0.0015
SUMS	2341.1128	-12.1964	0.9038	0.2462

DAYS 313 THRU 318 JD 2444551.5 TO 2444557.5 DATES NOV 8 THRU NOV 13

A = 3.00000000 B = -105.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1226.9690	-19.3890	0.9191	0.2504
1	1043.9693	-3.7344	0.0192	0.0052
2	-1.6860	4.0596	0.0060	0.0016
3	0.3786	0.5157	0.0103	0.0028
4	0.1464	-0.1215	-0.0002	-0.0001
5	-0.0312	-0.0353	-0.0081	-0.0022
SUMS	2269.7461	-18.7049	0.9463	0.2577

DAYS 319 THRU 324 JD 2444557.5 TO 2444563.5 DATES NOV 14 THRU NOV 19

A = 3.00000000 B = -107.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1151.9749	-9.2305	0.9848	0.2683
1	1042.3145	13.0748	0.0385	0.0105
2	-0.1559	2.8219	-0.0034	-0.0009
3	-0.4388	-0.9701	-0.0055	-0.0015
4	-0.1489	-0.1951	-0.0008	-0.0002
5	0.0502	-0.0033	0.0009	0.0002
SUMS	2193.5960	5.4977	1.0145	0.2764

DAYS 325 THRU 330 JD 2444563.5 TO 2444569.5 DATES NOV 20 THRU NOV 25

A = 3.00000000 B = -109.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1072.0958	17.6526	1.0081	0.2747
1	1037.0274	7.8164	-0.0286	-0.0078
2	-0.6178	-5.5042	-0.0197	-0.0054
3	1.2485	-0.7798	0.0067	0.0018
4	0.2634	0.4408	0.0022	0.0006
5	-0.1328	0.0534	-0.0023	-0.0006
SUMS	2109.8845	19.6792	0.9664	0.2633

DAYS 331 THRU 336 JD 2444569.5 TO 2444575.5 DATES NOV 26 THRU DEC 1

A = 3.00000000 B = -111.33333333

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1353.1940	12.2056	0.9240	0.2518
1	1046.5637	-10.4071	-0.0349	-0.0095
2	2.7786	-2.0105	0.0098	0.0027
3	-0.7052	0.8377	0.0071	0.0019
4	-0.1624	-0.0916	0.0014	0.0004
5	0.0679	-0.0048	-0.0042	-0.0011
SUMS	2401.7366	0.5293	0.9032	0.2462

DAYS 337 THRU 342 JD 2444575.5 TO 2444581.5 DATES DEC 2 THRU DEC 7

A = 3.00000000 B = -113.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1290.9501	-11.1849	0.9047	0.2465
1	1048.0384	-10.5206	0.0101	0.0028
2	-1.7842	1.8580	0.0086	0.0024
3	-0.4851	0.7073	0.0013	0.0004
4	0.1575	0.0327	-0.0016	-0.0004
5	0.0338	-0.0112	-0.0021	-0.0006
SUMS	2336.9105	-19.1187	0.9210	0.2511

DAYS 343 THRU 348 JD 2444581.5 TO 2444587.5 DATES DEC 8 THRU DEC 13

A = 3.00000000 B = -115.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1219.3960	-19.2748	0.9448	0.2574
1	1041.8991	4.5282	0.0238	0.0065
2	0.1579	4.6673	0.0012	0.0003
3	0.6541	-0.2494	0.0043	0.0012
4	-0.1662	-0.2153	0.0	0.0
5	-0.0754	0.0167	-0.0035	-0.0010
SUMS	2261.8655	-10.5273	0.9706	0.2644

DAYS 349 THRU 354 JD 2444587.5 TO 2444593.5 DATES DEC 14 THRU DEC 19

A = 3.00000000 B = -117.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1144.9689	3.5988	0.9952	0.2711
1	1042.3269	14.7867	0.0196	0.0053
2	-1.5325	-0.5889	-0.0065	-0.0018
3	-0.7104	-1.3573	-0.0045	-0.0012
4	0.1432	-0.0841	-0.0029	-0.0008
5	0.0962	0.0238	0.0005	0.0001
SUMS	2185.2923	16.3790	1.0014	0.2727

DAYS 355 THRU 360 JD 2444593.5 TO 2444599.5 DATES DEC 20 THRU DEC 25

A = 3.00000000 B = -119.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1062.8462	20.2065	0.9779	0.2664
1	1038.3781	-1.9412	-0.0380	-0.0103
2	2.2766	-5.5183	-0.0086	-0.0023
3	1.2817	0.6825	0.0089	0.0024
4	-0.3097	0.3378	-0.0001	0.0
5	-0.1376	-0.0954	-0.0038	-0.0010
SUMS	2104.3353	13.6719	0.9363	0.2552

DAYS 361 THRU 366 JD 2444599.5 TO 2444605.5 DATES DEC 26 THRU DEC 31

A = 3.00000000 B = -121.33333333

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1351.8590	2.0504	0.9088	0.2476
1	1049.3113	-12.4054	-0.0176	-0.0048
2	0.9131	-0.1119	0.0126	0.0034
3	-0.9113	0.5894	0.0013	0.0004
4	-0.0020	-0.0542	-0.0005	-0.0001
5	0.0329	0.0285	-0.0004	-0.0001
SUMS	2401.2030	-9.9032	0.9042	0.2464

Section D: ASTRONOMICAL TABLES

With two exceptions the series in this section provide data referred to the true equinox and equator of date. The exceptions are

1. the Moon's geocentric, rectangular coordinates (X, Y, Z), which are referred to the mean equinox and equator of 1950.0;
2. the right ascension and declination of Pluto, which are astrometric (*i.e.*, free of stellar aberration, except for the elliptic part) and are referred to the mean equinox and equator of 1950.0.

The unit of distance for the Sun and planets is the Astronomical Unit; the unit of distance for the Moon is the Earth's radius.

DAYS 1 THRU 95 JD 2444239.5 TO 2444334.5 DATES JAN 1 THRU APR 4

A = 47.50000000 B = -1.02105263

	APP S T	EQ OF EQ	NUT LON	NUT OBL
TERM	H	S	"	"
0	19.55062063	-1.0281	-16.8090	-15.7391
1	3.12119476	-0.0787	-1.2864	0.8142
2	-0.00001131	-0.0407	-0.6655	-0.1437
3	0.00000070	0.0025	0.0410	-0.0699
4	0.00000016	0.0006	0.0094	-0.0048
5	-0.00000095	-0.0034	-0.0562	0.0095
6	-0.00000076	-0.0027	-0.0445	-0.0206
7	-0.00000007	-0.0003	-0.0042	-0.0022
8	-0.00000058	-0.0021	-0.0341	-0.0180
9	0.00000137	0.0049	0.0808	-0.0107
10	-0.00000005	-0.0002	-0.0028	-0.0018
11	0.00000028	0.0010	0.0164	-0.0148
12	0.00000038	0.0014	0.0222	0.0138
13	0.00000016	0.0006	0.0095	-0.0018
14	0.00000056	0.0020	0.0331	0.0171
15	-0.00000085	-0.0031	-0.0502	0.0165
16	-0.00000038	-0.0014	-0.0223	-0.0121
17	-0.00000009	-0.0003	-0.0053	0.0025
18	-0.00000059	-0.0021	-0.0346	-0.0180
19	0.00000105	0.0038	0.0618	-0.0223
20	0.00000097	0.0035	0.0568	0.0289
21	-0.00000098	-0.0035	-0.0576	0.0210
22	-0.00000059	-0.0021	-0.0350	-0.0175
23	0.00000040	0.0014	0.0235	-0.0086
24	0.00000014	0.0005	0.0084	0.0045
25	-0.00000006	-0.0002	-0.0036	0.0010
26	-0.00000001	0.0	-0.0007	-0.0010
27	0.00000007	0.0003	0.0042	-0.0010
28	0.00000009	0.0003	0.0051	0.0029
29	-0.00000015	-0.0005	-0.0087	0.0030
30	-0.00000014	-0.0005	-0.0079	-0.0037
31	0.00000013	0.0005	0.0074	-0.0030
32	0.00000010	0.0004	0.0058	0.0022
33	-0.00000005	-0.0002	-0.0031	0.0016
34	-0.00000004	-0.0001	-0.0024	-0.0007
35	0.00000002	0.0001	0.0011	-0.0006
SUMS	22.67180432	-1.1464	-18.7476	-15.1772

DAYS 92 THRU 186 JD 2444330.5 TO 2444425.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.93684211

TERM	APP S T	EQ OF EQ	NUT LON	NUT OBL
	H	S	''	''
0	31.50973204	-1.3034	-21.3091	-15.2470
1	3.12121616	-0.0017	-0.0271	-0.3216
2	0.00000935	0.0337	0.5505	0.1435
3	-0.00000069	-0.0025	-0.0407	0.0759
4	-0.00000083	-0.0030	-0.0489	0.0130
5	0.00000038	0.0014	0.0224	0.0008
6	0.00000015	0.0005	0.0086	0.0268
7	-0.00000035	-0.0013	-0.0206	0.0004
8	0.00000023	0.0008	0.0138	0.0231
9	-0.00000086	-0.0031	-0.0507	-0.0016
10	-0.00000076	-0.0027	-0.0445	0.0010
11	-0.00000094	-0.0034	-0.0556	-0.0079
12	0.00000041	0.0015	0.0241	-0.0200
13	-0.00000010	-0.0004	-0.0060	-0.0007
14	0.00000020	0.0007	0.0118	-0.0241
15	0.00000112	0.0040	0.0661	0.0066
16	-0.00000017	-0.0006	-0.0100	0.0147
17	0.00000028	0.0010	0.0163	0.0
18	-0.00000029	-0.0011	-0.0172	0.0251
19	-0.00000134	-0.0048	-0.0791	-0.0110
20	0.00000058	0.0021	0.0343	-0.0336
21	0.00000111	0.0040	0.0651	0.0120
22	-0.00000034	-0.0012	-0.0202	0.0206
23	-0.00000057	-0.0020	-0.0334	-0.0032
24	0.0	0.0	-0.0002	-0.0096
25	0.00000025	0.0009	0.0149	-0.0015
26	0.00000003	0.0001	0.0016	0.0039
27	-0.00000007	-0.0003	-0.0044	-0.0011
28	0.00000011	0.0004	0.0066	-0.0003
29	-0.00000004	-0.0001	-0.0021	0.0038
30	-0.00000016	-0.0006	-0.0091	-0.0013
31	0.00000006	0.0002	0.0033	-0.0034
32	0.00000011	0.0004	0.0063	0.0010
33	-0.00000002	-0.0001	-0.0013	0.0020
34	-0.00000006	-0.0002	-0.0035	-0.0002
35	0.0	0.0	0.0002	-0.0011
SUMS	34.63095498	-1.2808	-20.9378	-15.3150

CHEBYSHEV APPROXIMATION OF SIDEREAL TIME FOR YEAR 1980

DAYS 183 THRU 277   JD 2444421.5 TO 2444516.5   DATES JULY 1 THRU OCT 3

A = 47.50000000   B = -4.85263158

TERM	APP S T H	EQ OF EQ S	NUT LON ″	NUT OBL ″
0	43.46891292	-1.3286	-21.7212	-13.9006
1	3.12119702	-0.0705	-1.1534	0.8392
2	-0.00000906	-0.0326	-0.5330	-0.0955
3	0.00000129	0.0046	0.0757	-0.0875
4	0.00000168	0.0061	0.0990	0.0008
5	0.00000031	0.0011	0.0183	-0.0013
6	0.00000087	0.0031	0.0512	-0.0048
7	-0.00000001	0.0	-0.0004	0.0078
8	0.00000047	0.0017	0.0275	-0.0054
9	-0.00000043	-0.0015	-0.0250	0.0198
10	0.00000047	0.0017	0.0276	-0.0019
11	0.00000058	0.0021	0.0342	0.0291
12	-0.00000108	-0.0039	-0.0636	0.0052
13	-0.00000009	-0.0003	-0.0050	0.0016
14	-0.00000100	-0.0036	-0.0587	0.0049
15	-0.00000022	-0.0008	-0.0129	-0.0302
16	0.00000059	0.0021	0.0348	-0.0046
17	-0.00000005	-0.0002	-0.0027	-0.0090
18	0.00000107	0.0038	0.0629	-0.0062
19	0.00000038	0.0014	0.0226	0.0344
20	-0.00000129	-0.0047	-0.0760	0.0104
21	-0.00000033	-0.0012	-0.0192	-0.0266
22	0.00000082	0.0030	0.0483	-0.0053
23	0.00000010	0.0003	0.0057	0.0160
24	-0.00000049	-0.0017	-0.0286	0.0011
25	-0.00000002	-0.0001	-0.0013	-0.0084
26	0.00000018	0.0007	0.0107	-0.0009
27	0.00000004	0.0002	0.0026	0.0009
28	0.00000007	0.0002	0.0040	0.0013
29	-0.00000005	-0.0002	-0.0030	0.0032
30	-0.00000014	-0.0005	-0.0083	-0.0013
31	0.00000005	0.0002	0.0030	-0.0033
32	0.00000011	0.0004	0.0063	0.0012
33	-0.00000005	-0.0002	-0.0028	0.0021
34	-0.00000007	-0.0002	-0.0038	-0.0009
35	0.00000003	0.0001	0.0015	-0.0012
SUMS	46.59010467	-1.4180	-23.1830	-13.2159

DAYS 275 THRU 369 JD 2444513.5 TO 2444608.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.78947368

TERM	APP S T	EQ OF EQ	NUT LON	NUT OBL
	H	S	''	''
0	7.55944755	-1.5910	-26.0114	-13.1825
1	3.12121705	0.0016	0.0254	-0.3022
2	0.00001169	0.0421	0.6881	0.1015
3	-0.00000241	-0.0087	-0.1417	0.0910
4	-0.00000080	-0.0029	-0.0471	-0.0245
5	-0.00000093	-0.0033	-0.0546	-0.0016
6	-0.00000036	-0.0013	-0.0213	-0.0261
7	-0.00000001	0.0	-0.0008	-0.0005
8	-0.00000064	-0.0023	-0.0375	-0.0253
9	0.00000139	0.0050	0.0819	-0.0029
10	0.00000028	0.0010	0.0163	-0.0018
11	0.00000056	0.0020	0.0331	-0.0096
12	0.00000014	0.0005	0.0081	0.0168
13	0.00000025	0.0009	0.0148	0.0008
14	0.00000023	0.0008	0.0136	0.0224
15	-0.00000108	-0.0039	-0.0637	0.0090
16	-0.00000027	-0.0010	-0.0158	-0.0146
17	-0.00000022	-0.0008	-0.0129	-0.0001
18	-0.00000023	-0.0008	-0.0137	-0.0233
19	0.00000141	0.0051	0.0827	-0.0132
20	0.00000054	0.0019	0.0317	0.0359
21	-0.00000126	-0.0045	-0.0739	0.0133
22	-0.00000032	-0.0012	-0.0189	-0.0222
23	0.00000055	0.0020	0.0325	-0.0042
24	0.00000001	0.0	0.0006	0.0072
25	-0.00000013	-0.0005	-0.0079	-0.0009
26	0.00000002	0.0001	0.0011	-0.0017
27	0.00000006	0.0002	0.0037	-0.0012
28	0.00000012	0.0004	0.0070	0.0017
29	-0.00000009	-0.0003	-0.0055	0.0041
30	-0.00000017	-0.0006	-0.0102	-0.0022
31	0.00000010	0.0004	0.0058	-0.0038
32	0.00000011	0.0004	0.0066	0.0020
33	-0.00000007	-0.0003	-0.0043	0.0018
34	-0.00000004	-0.0001	-0.0024	-0.0013
35	0.00000003	0.0001	0.0020	-0.0006
SUMS	10.68067306	-1.5590	-25.4886	-13.3588

CHEBYSHEV APPROXIMATION OF SOLAR COORDINATES FOR YEAR 1980

DAYS 1 THRU 95 JD 2444239.5 TO 2444334.5 DATES JAN 1 THRU APR 4

A = 47.50000000 B = -1.02105263

TERM	R A H	DEC DEG	DISTANCE AU	S D •	EPHEM TR H
0	43.8252908	-20.690664	1.98007142	32.36316	24.2750322
1	3.1082617	15.049584	0.00888604	-0.14497	-0.0165095
2	-0.0932496	1.830347	0.00188872	-0.03026	-0.0925624
3	0.0117060	-0.488874	-0.00027364	0.00474	0.0120870
4	0.0043653	-0.001765	-0.00003948	0.00063	0.0042775
5	-0.0008231	0.005123	0.00000706	-0.00013	-0.0008233
6	-0.0000001	-0.001379	0.00000200	-0.00003	0.0000055
7	-0.0000231	-0.000111	0.00000339	-0.00005	-0.0000227
8	0.0000136	0.000133	0.00001835	-0.00030	0.0000220
9	0.0000706	0.000243	-0.00000509	0.00008	0.0000663
10	-0.0000163	-0.000006	-0.00001300	0.00021	-0.0000218
11	-0.0000308	-0.000117	0.00000220	-0.00004	-0.0000296
12	0.0000062	-0.000018	0.00000401	-0.00007	0.0000070
13	0.0000060	0.000033	-0.00000044	0.00001	0.0000059
14	-0.0000003	0.000005	-0.00000043	0.00001	-0.0000010
15	-0.0000011	-0.000012	0.00000006	0.0	-0.0000006
16	0.0000004	0.000003	0.00000016	0.0	0.0000006
17	0.0000013	0.000004	-0.00000012	0.0	0.0000013
18	-0.0000012	-0.000006	-0.00000045	0.00001	-0.0000009
19	-0.0000008	0.000002	0.00000012	0.0	-0.0000018
20	0.0000015	0.000003	0.00000038	-0.00001	0.0000008
21	0.0	-0.000003	-0.00000004	0.0	0.0000004
SUMS	46.8555770	-4.297475	1.99055122	32.19299	24.1815329

DAYS 92 THRU 186 JD 2444330.5 TO 2444425.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.93684211

TERM	R A H	DEC DEG	DISTANCE AU	S D •	EPHEM TR H
0	7.5291624	33.224639	2.01971231	31.72792	24.0192352
1	3.1321042	9.423159	0.00891388	-0.14028	0.0132327
2	0.0651046	-2.994778	-0.00184393	0.02955	0.0646454
3	-0.0070801	-0.290505	-0.00023986	0.00351	-0.0074684
4	-0.0049734	0.036977	0.00001763	-0.00028	-0.0049642
5	0.0000614	0.005883	0.00001225	-0.00018	0.0000837
6	0.0001644	0.000282	0.00000187	-0.00003	0.0001672
7	-0.0000162	-0.000401	0.00000841	-0.00013	-0.0000126
8	0.0000518	0.000059	0.00001375	-0.00022	0.0000568
9	0.0000486	0.000204	-0.00001310	0.00021	0.0000439
10	-0.0000388	-0.000121	-0.00000931	0.00014	-0.0000417
11	-0.0000237	-0.000071	0.00000595	-0.00009	-0.0000198
12	0.0000118	0.000050	0.00000293	-0.00005	0.0000127
13	0.0000061	0.000009	-0.00000124	0.00002	0.0000061
14	-0.0000011	-0.000016	-0.00000085	0.00001	-0.0000019
15	-0.0000004	-0.000003	0.00000011	0.0	-0.0000020
16	0.0000001	0.000005	0.00000011	0.0	0.0000005
17	-0.0000002	0.000006	-0.00000025	0.0	-0.0000007
18	-0.0000013	-0.000001	0.00000027	0.0	-0.0000014
19	-0.0000002	-0.000007	0.00000032	-0.00001	0.0000016
20	0.0000013	0.000002	-0.00000027	0.0	0.0000013
21	0.0000006	0.000004	-0.00000017	0.0	-0.0000010
SUMS	10.7145819	39.405376	2.02658081	31.62009	24.0849734

DAYS 183 THRU 277 JD 2444421.5 TO 2444516.5 DATES JULY 1 THRU OCT 3

A = 47.50000000 B = -4.85263158

TERM	R A H	DEC DEG	DISTANCE AU	S D "	EPHEM TR H
0	19.4649755	22.658960	2.02063543	31.71332	23.9938919
1	2.9862415	-14.093162	-0.00849206	0.13353	-0.1373198
2	-0.0642486	-1.944470	-0.00190943	0.03050	-0.0635514
3	0.0112369	0.378959	0.00023658	-0.00346	0.0115486
4	0.0036872	0.010840	0.00002399	-0.00038	0.0036332
5	-0.0004706	-0.002460	0.00001362	-0.00022	-0.0004684
6	-0.0000081	0.000818	0.00000047	-0.00001	-0.0000070
7	0.0000015	-0.000090	0.00001186	-0.00019	0.0000055
8	0.0000708	-0.000283	0.00000412	-0.00006	0.0000717
9	0.0000144	-0.000081	-0.00001804	0.00028	0.0000067
10	-0.0000502	0.000141	-0.00000304	0.00005	-0.0000510
11	-0.0000048	0.000074	0.00000771	-0.00012	-0.0000026
12	0.0000145	-0.000045	0.00000085	-0.00001	0.0000161
13	0.0000006	-0.000016	-0.00000216	0.00003	-0.0000001
14	-0.0000055	0.000023	-0.00000007	0.0	-0.0000044
15	-0.0000002	0.000004	0.00000055	-0.00001	0.0000005
16	0.0000011	0.0	0.00000011	0.0	0.0000006
17	0.0000002	-0.000010	0.00000020	0.0	0.0000007
18	0.0000023	-0.000014	-0.00000016	0.0	0.0000012
19	0.0000001	0.000005	-0.00000040	0.00001	-0.0000009
20	-0.0000026	0.000014	0.00000013	0.0	-0.0000011
21	0.0	-0.000004	0.00000025	0.0	0.0000011
SUMS	22.4014560	7.009203	2.01051051	31.87326	23.8077711

DAYS 275 THRU 369 JD 2444513.5 TO 2444608.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.78947368

TERM	R A H	DEC DEG	DISTANCE AU	S D "	EPHEM TR H
0	31.2781359	-31.970707	1.98072699	32.35252	23.7209870
1	3.2555932	-10.194306	-0.00915090	0.14920	0.1380913
2	0.1015843	3.067872	0.00184227	-0.02945	0.1010255
3	-0.0088604	0.409308	0.00028612	-0.00495	-0.0093719
4	-0.0066965	-0.036714	-0.00001964	0.00030	-0.0067080
5	-0.0001112	-0.011081	0.00000980	-0.00015	-0.0000804
6	0.0002376	-0.000573	-0.00000084	0.00001	0.0002437
7	0.0000669	0.000374	0.00001071	-0.00017	0.0000702
8	0.0000606	-0.000198	-0.00000940	0.00015	0.0000570
9	-0.0000366	0.000073	-0.00001597	0.00026	-0.0000443
10	-0.0000478	0.000177	0.00000640	-0.00010	-0.0000451
11	0.0000148	-0.000069	0.00000725	-0.00012	0.0000173
12	0.0000151	-0.000059	-0.00000208	0.00003	0.0000143
13	-0.0000026	0.000026	-0.00000140	0.00002	-0.0000034
14	-0.0000013	0.0	0.00000045	-0.00001	-0.0000017
15	-0.0000005	-0.000002	0.00000006	0.0	0.0000004
16	0.0000005	-0.000004	0.0	0.0	0.0000010
17	0.0000001	0.0	-0.00000033	0.00001	0.0000002
18	-0.0000020	0.000014	-0.00000011	0.0	-0.0000013
19	0.0000013	0.0	0.00000044	-0.00001	0.0
20	0.0000020	-0.000015	0.00000006	0.0	0.0000009
21	-0.0000015	-0.000001	-0.00000027	0.0	-0.0000003
SUMS	34.6199519	-38.735885	1.97368961	32.46754	23.9442524

CHEBYSHEV APPROXIMATION OF LUNAR COORDINATES FOR YEAR 1980

DAYS 1 THRU 32 JD 2444239.5 TO 2444271.5 DATES JAN 1 THRU FEB 1

A = 16.00000000 B = -1.06250000

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	"	E RAD	E RAD	E RAD
0	38.88036949	15.2779045	112.9334524	-24.4148811	44.5533702	16.4995728
1	14.12376638	0.3483010	0.1703020	7.1236324	2.4264076	0.4733133
2	0.28110339	15.6594223	-1.3780563	-16.7677235	45.2109862	16.3965117
3	-0.14100864	-3.4571673	-1.8489109	-46.1269545	-16.1257269	-3.2809740
4	-0.15406673	-8.6793795	0.9440878	8.8380358	-24.9453956	-8.9795920
5	0.12541922	0.3684133	0.6200385	11.9296774	3.3448934	0.5622967
6	0.00416658	1.6870022	-0.3452754	-0.6924400	4.3642565	1.5262189
7	-0.07210324	0.2873149	-0.1768422	-1.7739410	0.0724677	0.1123510
8	0.00175507	-0.3953298	0.0907801	-0.2165768	-0.6850075	-0.2238642
9	0.02489092	-0.1067571	0.0620679	0.3174423	-0.1414975	-0.0641163
10	0.00323205	0.1386506	-0.0169519	0.0893345	0.1393204	0.0433624
11	-0.00774136	0.0277511	-0.0215390	-0.0675499	0.0448902	0.0186985
12	-0.00173189	-0.0490785	0.0022319	-0.0262760	-0.0297187	-0.0088955
13	0.00274530	-0.0121634	0.0068136	0.0139932	-0.0134736	-0.0053054
14	0.00051081	0.0165030	0.0000881	0.0080151	0.0059834	0.0016569
15	-0.00107418	0.0057661	-0.0020307	-0.0026758	0.0041629	0.0015587
16	-0.00019501	-0.0054923	-0.0002614	-0.0024332	-0.0010876	-0.0002531
17	0.00043092	-0.0022739	0.0005872	0.0004336	-0.0012422	-0.0004472
18	0.00010008	0.0018677	0.0001503	0.0007061	0.0001514	0.0000172
19	-0.00016960	0.0008456	-0.0001632	-0.0000376	0.0003543	0.0001233
20	-0.00004691	-0.0006640	-0.0000657	-0.0001972	-0.0000010	0.0000093
21	0.00006567	-0.0003290	0.0000426	-0.0000123	-0.0000979	-0.0000329
22	0.00002004	0.0002440	0.0000254	0.0000535	-0.0000109	-0.0000064
23	-0.00002585	0.0001320	-0.0000101	0.0000096	0.0000263	0.0000085
24	-0.00000861	-0.0000899	-0.0000089	-0.0000141	0.0000061	0.0000028
25	0.00001043	-0.0000528	0.0000020	-0.0000043	-0.0000068	-0.0000020
26	0.00000383	0.0000332	0.0000030	0.0000035	-0.0000025	-0.0000011
27	-0.00000424	0.0000212	-0.0000003	0.0000017	0.0000018	0.0000005
28	-0.00000169	-0.0000125	-0.0000010	-0.0000009	0.0000010	0.0000003
29	0.00000168	-0.0000085	-0.0000001	-0.0000005	-0.0000004	-0.0000001
30	0.00000074	0.0000048	0.0000005	0.0000002	-0.0000004	-0.0000001
31	-0.00000067	0.0000034	0.0000001	0.0000002	0.0	0.0
SUMS	53.07041398	21.1113824	111.0405563	-61.7703796	58.2240099	23.0722125

DAYS 32 THRU 63 JD 2444270.5 TO 2444302.5 DATES FEB 1 THRU MAR 3

A = 16.00000000 B = -3.00000000

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	'	E RAD	E RAD	E RAD
0	45.18418615	7.9594502	111.7821600	-53.6801468	18.4708020	9.0328826
1	14.13635842	2.0803755	-0.0202589	2.8892821	6.5996993	2.1063120
2	0.11849323	7.7863282	-2.6827776	-46.6042319	17.6083161	8.3845762
3	-0.38241521	-13.0056962	-0.5247829	-18.8593681	-42.6035538	-13.6426994
4	-0.03092560	-4.5017339	1.6750525	25.8533167	-9.8916749	-4.6921813
5	0.09018804	3.6887256	0.0802352	5.1687902	11.2244832	3.5800959
6	-0.05796054	1.1601390	-0.5813700	-4.6780330	2.0035533	0.9223636
7	-0.00480967	-0.7853213	0.0095531	-0.9688879	-1.7840873	-0.5612083
8	0.03577371	-0.2859257	0.1914915	0.8019406	-0.4116580	-0.1814831
9	-0.00131069	0.2318430	-0.0025910	0.2164550	0.3615059	0.1127537
10	-0.01354029	0.0481371	-0.0597629	-0.1888489	0.0974100	0.0428928
11	0.00093983	-0.0788165	0.0001966	-0.0525563	-0.0925563	-0.0290212
12	0.00430408	-0.0007021	0.0189284	0.0502650	-0.0243071	-0.0108617
13	-0.00081382	0.0272039	-0.0001062	0.0135990	0.0250277	0.0078794
14	-0.00115998	-0.0036260	-0.0061235	-0.0137489	0.0065095	0.0029242
15	0.00055648	-0.0090754	0.0000742	-0.0037420	-0.0069220	-0.0021805
16	0.00025997	0.0022418	0.0020000	0.0038524	-0.0018244	-0.0008203
17	-0.00029921	0.0027692	-0.0000329	0.0010609	0.0019668	0.0006196
18	-0.00003902	-0.0010552	-0.0006575	-0.0011091	0.0005218	0.0002353
19	0.00013436	-0.0007326	0.0000123	-0.0003057	-0.0005732	-0.0001806
20	-0.00000642	0.0004486	0.0002172	0.0003265	-0.0001513	-0.0000686
21	-0.00005201	0.0001499	-0.0000046	0.0000892	0.0001702	0.0000537
22	0.00001084	-0.0001780	-0.0000721	-0.0000976	0.0000442	0.0000201
23	0.00001762	-0.0000112	0.0000015	-0.0000262	-0.0000514	-0.0000162
24	-0.00000748	0.0000653	0.0000241	0.0000296	-0.0000130	-0.0000060
25	-0.00000515	-0.0000108	-0.0000005	0.0000078	0.0000156	0.0000050
26	0.00000407	-0.0000213	-0.0000080	-0.0000092	0.0000038	0.0000020
27	0.00000117	0.0000087	0.0000002	-0.0000023	-0.0000048	-0.0000015
28	-0.00000189	0.0000059	0.0000028	0.0000028	-0.0000011	-0.0000005
29	-0.00000009	-0.0000048	-0.0000001	0.0000006	0.0000014	0.0000005
30	0.00000080	-0.0000013	-0.0000009	-0.0000008	0.0000004	0.0000002
31	-0.00000011	0.0000018	0.0	-0.0000002	-0.0000004	-0.0000002
SUMS	59.07788159	4.3149814	109.8814000	-90.0520965	1.5826522	5.0728874

DAYS 61 THRU 92 JD 2444299.5 TO 2444331.5 DATES MAR 1 THRU APR 1

A = 16.00000000 B = -4.81250000

TERM	R A H	DEC DEG	H P "	X E RAD	Y E RAD	Z E RAD
0	48.00221631	2.4978991	111.6215184	-58.0999984	0.2888843	3.0225666
1	14.14262056	2.4136078	-0.0290270	0.1047152	7.0047679	2.3905933
2	0.00796216	2.2262096	-2.8954424	-50.3379405	-0.0106078	2.4953849
3	-0.43234338	-14.8401684	0.0588382	-0.8409182	-45.8639998	-15.7264328
4	0.00774110	-1.3007822	1.7891658	28.0680845	0.0330432	-1.4197338
5	0.07369877	4.4014902	-0.0470592	0.1864378	12.2542577	4.2009050
6	-0.02324448	0.2989084	-0.6275584	-5.2580452	-0.0360607	0.2576925
7	0.01967131	-1.0191113	0.0266380	-0.0065902	-2.0573412	-0.7062114
8	0.01316539	-0.0538902	0.2097871	0.9630640	0.0211481	-0.0419362
9	-0.01440672	0.2687297	-0.0106903	-0.0077679	0.4385512	0.1510449
10	-0.00484041	-0.0025487	-0.0662378	-0.2334531	-0.0097318	0.0085340
11	0.00578805	-0.0670108	0.0040681	0.0045907	-0.1138318	-0.0393418
12	0.00132308	0.0080826	0.0213205	0.0627333	0.0038525	-0.0018657
13	-0.00186166	0.0150339	-0.0015749	-0.0019230	0.0311326	0.0107947
14	-0.00017821	-0.0045909	-0.0070359	-0.0174065	-0.0013906	0.0004074
15	0.00047566	-0.0029302	0.0006043	0.0007195	-0.0087500	-0.0030441
16	-0.00006864	0.0018702	0.0023410	0.0049625	0.0004883	-0.0000853
17	-0.00008152	0.0004516	-0.0002284	-0.0002611	0.0025288	0.0008828
18	0.00006859	-0.0006082	-0.0007826	-0.0014533	-0.0001713	0.0000157
19	-0.00000325	-0.0000424	0.0000857	0.0000938	-0.0007488	-0.0002623
20	-0.00003482	0.0001533	0.0002631	0.0004342	0.0000602	-0.0000018
21	0.00001116	0.0000015	-0.0000320	-0.0000333	0.0002252	0.0000792
22	0.00001304	-0.0000224	-0.0000889	-0.0001314	-0.0000211	-0.0000005
23	-0.00000656	-0.0000038	0.0000119	0.0000118	-0.0000684	-0.0000241
24	-0.00000364	-0.0000039	0.0000301	0.0000400	0.0000074	0.0000004
25	0.00000275	0.0000046	-0.0000044	-0.0000041	0.0000210	0.0000074
26	0.00000057	0.0000049	-0.0000102	-0.0000124	-0.0000025	-0.0000002
27	-0.00000098	-0.0000031	0.0000017	0.0000016	-0.0000064	-0.0000024
28	0.00000012	-0.0000022	0.0000033	0.0000038	0.0000009	0.0000001
29	0.00000026	0.0000016	-0.0000005	-0.0000004	0.0000019	0.0000008
30	-0.00000013	0.0000007	-0.0000011	-0.0000012	-0.0000003	0.0000001
31	-0.00000003	-0.0000010	0.0000004	0.0	-0.0000006	-0.0000001
SUMS	61.79768445	-5.1592700	110.0489036	-85.4100475	-28.0237619	-5.4000327

DAYS 92 THRU 123 JD 2444330.5 TO 2444362.5 DATES APR 1 THRU MAY 2

A = 16.00000000 B = -6.75000000

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	"	E RAD	E RAD	E RAD
0	54.17443563	-9.2623436	112.2318916	-42.8854977	-34.6129894	-9.8354412
1	14.13489237	1.7285943	-0.2899608	-5.4216058	4.5256169	1.8073498
2	-0.29145028	-10.1188402	-2.2122576	-34.4396787	-35.6959301	-10.6999373
3	-0.30403136	-11.9473326	1.6343867	35.3291678	-30.9684001	-12.5817640
4	0.13874520	5.8644972	1.2976242	18.7966592	20.0053606	5.9580662
5	0.07580642	3.0318662	-0.7115367	-9.7520071	7.5133702	3.1169656
6	0.02419131	-1.6098592	-0.3808169	-2.7626367	-3.9906818	-1.2358750
7	-0.00979050	-0.3915583	0.2723103	1.8287763	-0.7388300	-0.3514603
8	-0.02520714	0.4695175	0.0909078	0.1931965	0.8136943	0.2717359
9	0.00458228	0.0554055	-0.0960010	-0.4219874	0.0167237	0.0276978
10	0.00982356	-0.1218312	-0.0136150	0.0155405	-0.1996020	-0.0700122
11	-0.00280469	-0.0119735	0.0319016	0.1057797	0.0210977	0.0018272
12	-0.00301976	0.0285587	-0.0006214	-0.0168520	0.0493867	0.0179995
13	0.00098141	0.0042356	-0.0101537	-0.0258077	-0.0117307	-0.0027293
14	0.00080712	-0.0069994	0.0016633	0.0078908	-0.0116970	-0.0044654
15	-0.00018340	-0.0018117	0.0030456	0.0059655	0.0047896	0.0013523
16	-0.00022739	0.0018887	-0.0009755	-0.0030189	0.0025804	0.0010517
17	-0.00001485	0.0006473	-0.0008474	-0.0012599	-0.0017119	-0.0005290
18	0.00008333	-0.0005200	0.0004418	0.0010389	-0.0004972	-0.0002266
19	0.00002901	-0.0001775	0.0002117	0.0002185	0.0005639	0.0001845
20	-0.00003500	0.0001202	-0.0001761	-0.0003330	0.0000660	0.0000404
21	-0.00001470	0.0000388	-0.0000437	-0.0000178	-0.0001749	-0.0000599
22	0.00001366	-0.0000123	0.0000645	0.0001008	0.0000048	-0.0000036
23	0.00000564	-0.0000080	0.0000048	-0.0000086	0.0000512	0.0000183
24	-0.00000452	-0.0000077	-0.0000218	-0.0000288	-0.0000085	-0.0000015
25	-0.00000211	0.0000026	0.0000017	0.0000065	-0.0000141	-0.0000052
26	0.00000123	0.0000064	0.0000071	0.0000078	0.0000044	0.0000012
27	0.00000086	-0.0000011	-0.0000017	-0.0000031	0.0000036	0.0000015
28	-0.00000028	-0.0000029	-0.0000021	-0.0000018	-0.0000019	-0.0000006
29	-0.00000036	0.0000006	0.0000009	0.0000013	-0.0000007	-0.0000003
30	0.00000005	0.0000010	0.0000007	0.0000004	0.0000007	0.0000001
31	0.00000015	-0.0000003	-0.0000001	-0.0000005	0.0000002	0.0000001
SUMS	67.92761289	-22.2878989	111.8474328	-39.4463950	-73.2789554	-23.5782193

DAYS 122 THRU 153 JD 2444360.5 TO 2444392.5 DATES MAY 1 THRU JUNE 1

A = 16.00000000 B = -8.62500000

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	'	E RAD	E RAD	E RAD
0	58.84281373	-14.8577044	113.3578375	-15.7641972	-46.9030981	-15.6197350
1	14.12477910	0.4111467	-0.2906448	-7.1483915	0.7214326	0.5899588
2	-0.34159832	-15.8835842	-0.9529978	-6.7437986	-48.0172072	-16.5692713
3	-0.07883082	-4.5661791	2.1863562	48.4090394	-5.8215801	-4.6930302
4	0.18891156	8.7687078	0.5441080	3.2383044	26.3164916	9.0369795
5	0.09168467	0.5195581	-0.8353705	-12.1919825	0.4824252	0.8444612
6	-0.00838265	-1.6381660	-0.1337773	0.4668526	-4.2250557	-1.4999795
7	-0.05823528	0.3756668	0.2530662	1.5371725	0.6235676	0.1334774
8	-0.00227300	0.3309236	0.0015371	-0.4772154	0.4909667	0.1975472
9	0.02034493	-0.1550141	-0.0701948	-0.1883255	-0.2745630	-0.0858235
10	-0.00350570	-0.0964787	0.0162283	0.1558104	-0.0597920	-0.0294575
11	-0.00601644	0.0412648	0.0171485	0.0200409	0.0757901	0.0254376
12	0.00203832	0.0290403	-0.0088922	-0.0397878	0.0022861	0.0029778
13	0.00188175	-0.0146951	-0.0034056	0.0020891	-0.0183206	-0.0065279
14	-0.00060214	-0.0083609	0.0033449	0.0093038	0.0029414	0.0005218
15	-0.00066140	0.0059974	0.0003425	-0.0024106	0.0040532	0.0015507
16	0.00020056	0.0022798	-0.0010692	-0.0019437	-0.0015958	-0.0004529
17	0.00025800	-0.0021319	0.0001221	0.0010317	-0.0007588	-0.0003218
18	-0.00009488	-0.0005944	0.0002999	0.0003172	0.0005777	0.0001852
19	-0.00009857	0.0006926	-0.0001004	-0.0003404	0.0000902	0.0000501
20	0.00004393	0.0001715	-0.0000710	-0.0000182	-0.0001745	-0.0000601
21	0.00003478	-0.0002318	0.0000456	0.0000969	0.0000105	-0.0000016
22	-0.00001822	-0.0000591	0.0000123	-0.0000145	0.0000462	0.0000170
23	-0.00001215	0.0000832	-0.0000165	-0.0000242	-0.0000123	-0.0000030
24	0.00000729	0.0000209	-0.0000003	0.0000089	-0.0000106	-0.0000043
25	0.00000447	-0.0000314	0.0000052	0.0000051	0.0000056	0.0000016
26	-0.00000299	-0.0000072	-0.0000011	-0.0000034	0.0000019	0.0000009
27	-0.00000170	0.0000117	-0.0000013	-0.0000007	-0.0000020	-0.0000008
28	0.00000126	0.0000024	0.0000005	0.0000011	-0.0000002	-0.0000001
29	0.00000060	-0.0000044	0.0000003	-0.0000001	0.0000006	0.0000003
30	-0.00000054	-0.0000010	-0.0000002	-0.0000004	-0.0000001	0.0
31	-0.00000023	0.0000016	0.0	0.0000001	-0.0000001	-0.0000001
SUMS	72.77266992	-26.7376745	114.0839121	11.2816194	-76.6014839	-27.6715025

DAYS 153 THRU 184 JD 2444391.5 TO 2444423.5 DATES JUNE 1 THRU JULY 2

A = 16.00000000 B = -10.56250000

TERM	R A H	DEC DEG	H P "	X E RAD	Y E RAD	Z E RAD
0	65.47274394	-13.5775897	115.1402037	23.5502600	-35.6731159	-13.9781687
1	14.07545704	-1.3153208	-0.1505018	-5.2772033	-4.3112663	-1.2829947
2	-0.19718473	-14.4929847	1.0128166	34.4005291	-36.3335032	-14.9048715
3	0.16892614	8.4477969	1.8507913	37.5792652	30.8426466	8.6644833
4	0.17708236	7.5397717	-0.6381782	-18.6551761	19.2743665	7.8858404
5	-0.00770896	-2.2512255	-0.6894814	-8.1185401	-7.7209446	-2.2314438
6	-0.11387904	-0.5173719	0.1399673	2.9630384	-1.8871752	-0.8349861
7	-0.01793717	0.4501025	0.1479582	0.1107942	0.9502014	0.3264378
8	0.03860831	-0.2262666	-0.0447711	-0.3479414	-0.2495670	-0.0679243
9	-0.00097088	-0.1617616	-0.0119837	0.2038280	-0.1130179	-0.0517058
10	-0.00670343	0.0880989	0.0177329	0.0421079	0.1042796	0.0342375
11	0.00465682	0.0492143	-0.0044905	-0.0500811	0.0092881	0.0062087
12	0.00111236	-0.0269416	-0.0047889	0.0001617	-0.0196729	-0.0069258
13	-0.00238034	-0.0048356	0.0023084	0.0081034	0.0029059	0.0005503
14	-0.00027399	0.0098824	0.0006288	-0.0027152	0.0027131	0.0011131
15	0.00079290	-0.0026191	-0.0006888	-0.0009272	-0.0017390	-0.0005584
16	-0.00007656	-0.0034742	0.0000879	0.0010328	-0.0001720	-0.0001212
17	-0.00022257	0.0015891	0.0001601	-0.0000277	0.0004896	0.0001741
18	0.00012489	0.0008848	-0.0000786	-0.0002340	-0.0000763	-0.0000130
19	0.00005819	-0.0006435	-0.0000236	0.0000667	-0.0000876	-0.0000348
20	-0.00006755	-0.0000954	0.0000273	0.0000323	0.0000430	0.0000132
21	-0.00000977	0.0002570	-0.0000018	-0.0000264	0.0000068	0.0000041
22	0.00002561	-0.0000433	-0.0000065	0.0000003	-0.0000132	-0.0000047
23	-0.00000318	-0.0000917	0.0000026	0.0000068	0.0000022	0.0000004
24	-0.00000841	0.0000359	0.0000008	-0.0000019	0.0000026	0.0000010
25	0.00000402	0.0000250	-0.0000011	-0.0000011	-0.0000013	-0.0000004
26	0.00000240	-0.0000182	-0.0000001	0.0000008	-0.0000002	-0.0000002
27	-0.00000222	-0.0000036	0.0000004	0.0000001	0.0000003	0.0000002
28	-0.00000042	0.0000078	0.0	-0.0000002	0.0000001	0.0
29	0.00000092	-0.0000005	0.0	0.0	-0.0000001	0.0
30	-0.00000008	-0.0000028	0.0	-0.0000001	0.0000001	0.0
31	-0.00000034	0.0000009	0.0000001	0.0	0.0	0.0
SUMS	79.59216626	-15.9936231	116.7676903	66.4063519	-35.1234068	-16.4406893

D — Astronomy: Moon

CHEBYSHEV APPROXIMATION OF LUNAR COORDINATES FOR YEAR 1980

DAYS 183 THRU 214　　JD 2444421.5 TO 2444453.5　　DATES JULY 1 THRU AUG 1

A = 16.00000000　　B = -12.43750000

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	'	E RAD	E RAD	E RAD
0	70.34480156	-5.9393932	116.1332955	39.1106108	-10.3701357	-6.0752359
1	14.01423025	-2.0429043	0.1065862	-1.9813167	-6.2693969	-2.1313175
2	-0.02954539	-6.5206635	2.1279726	51.3148129	-10.0531089	-6.7582641
3	0.24226632	15.0387804	0.6799607	11.8055346	45.6620588	15.3669828
4	0.08574896	3.3742718	-1.2154545	-27.1423770	5.3488235	3.5663018
5	-0.12284466	-3.0969161	-0.4405596	-2.3465148	-10.1299726	-3.4160696
6	-0.08820486	-0.0999967	0.1619945	2.9991038	-0.3051606	-0.2921106
7	0.04982089	-0.0392440	0.1274464	-0.1728027	0.4090064	0.1533012
8	0.02751156	-0.2550036	-0.0049083	0.1082520	-0.2092185	-0.0805760
9	-0.01000059	0.0938129	-0.0048910	0.1445324	0.1127332	0.0308083
10	0.00042372	0.1151797	0.0019104	-0.0548902	0.0670244	0.0270018
11	0.00061939	-0.0206655	-0.0064580	-0.0294120	-0.0180244	-0.0045123
12	-0.00321542	-0.0222839	-0.0015920	0.0047494	-0.0087001	-0.0033501
13	-0.00000064	0.0053135	0.0016575	0.0016235	0.0010437	0.0002656
14	0.00132609	-0.0024316	0.0003251	-0.0004105	-0.0005226	-0.0001605
15	-0.00004044	-0.0023121	-0.0001048	0.0007403	-0.0002792	-0.0001444
16	-0.00022436	0.0029030	0.0000512	0.0002211	0.0004485	0.0001447
17	0.00009038	0.0007965	-0.0000204	-0.0002225	0.0001106	0.0000528
18	-0.00004096	-0.0009062	-0.0000423	-0.0000491	-0.0000801	-0.0000253
19	-0.00006290	-0.0000543	0.0000026	0.0000243	-0.0000099	-0.0000050
20	0.00003831	0.0001283	0.0000091	-0.0000032	0.0000042	0.0000016
21	0.00002123	-0.0001074	0.0	0.0000003	-0.0000051	-0.0000019
22	-0.00001279	0.0000141	-0.0000002	0.0000039	0.0000006	0.0
23	-0.00000102	0.0000641	0.0000005	-0.0000003	0.0000019	0.0000006
24	0.00000276	-0.0000153	-0.0000003	-0.0000009	-0.0000001	0.0
25	-0.00000277	-0.0000168	-0.0000003	0.0000001	-0.0000003	0.0000001
26	-0.00000033	0.0000068	0.0000002	0.0	0.0000001	0.0
27	0.00000155	0.0000003	0.0000002	0.0	0.0	-0.0000001
28	-0.00000008	-0.0000026	0.0000001	0.0000001	0.0	0.0
29	-0.00000039	0.0000019	0.0000001	0.0	0.0	0.0
30	0.00000014	0.0000009	-0.0000001	0.0	0.0000001	0.0
31	0.00000001	-0.0000011	0.0	0.0000001	0.0	0.0
SUMS	84.51270552	0.5883560	117.6671811	73.7622097	14.2366410	0.3830880

DAYS 214 THRU 245 JD 2444452.5 TO 2444484.5 DATES AUG 1 THRU SEPT 1

A = 16.00000000 B = -14.37500000

TERM	R A	DEC	H P	X	Y	Z
	H	DEG	"	E RAD	E RAD	E RAD
0	28.98733725	7.6824072	116.0579149	29.6243569	27.2429078	7.7393527
1	14.01297665	-2.0274879	0.4289668	3.3493433	-5.5891125	-2.1704959
2	0.17594414	8.0320393	2.0804956	42.6758423	30.3950827	8.0179288
3	0.26021924	14.4726524	-1.3575657	-28.7582751	37.2836184	14.9510238
4	-0.09249938	-3.8848476	-1.3779290	-22.8118622	-15.6310751	-4.0631460
5	-0.13385284	-3.1381737	-0.0069820	5.7539865	-8.6222846	-3.4015157
6	0.05626672	-0.0565719	0.3341314	2.7990367	1.1863029	0.2392177
7	0.05286014	-0.0277623	0.1554678	0.1647694	0.4936673	0.1635040
8	-0.01617364	0.2490674	-0.0272339	0.0609366	0.2720350	0.0922184
9	-0.01058545	0.1521950	-0.0349772	-0.1560232	0.1180641	0.0514717
10	-0.00190634	-0.0636564	-0.0147091	-0.0866275	-0.0507498	-0.0124031
11	-0.00012798	-0.0474876	-0.0017480	0.0061988	-0.0409801	-0.0148325
12	0.00271456	0.0030380	0.0050460	0.0173145	-0.0053465	-0.0029828
13	0.00076625	0.0067636	0.0028021	0.0059001	0.0046296	0.0012574
14	-0.00092048	0.0048240	-0.0000651	-0.0001127	0.0031030	0.0011013
15	-0.00031453	0.0007364	-0.0006400	-0.0013039	0.0008886	0.0003961
16	0.00008765	-0.0023000	-0.0003291	-0.0008136	-0.0003000	-0.0000543
17	0.00009499	-0.0007282	-0.0000275	-0.0000594	-0.0004202	-0.0001445
18	0.00007005	0.0004701	0.0000790	0.0001771	-0.0001121	-0.0000507
19	-0.00002032	0.0002531	0.0000523	0.0000890	0.0000422	0.0000093
20	-0.00004156	0.0000327	0.0000048	0.0000056	0.0000428	0.0000146
21	-0.00000119	-0.0000637	-0.0000110	-0.0000164	0.0000136	0.0000058
22	0.00001066	-0.0000623	-0.0000068	-0.0000107	-0.0000027	-0.0000003
23	0.00000411	0.0000092	-0.0000010	-0.0000019	-0.0000052	-0.0000018
24	-0.00000019	0.0000246	0.0000013	0.0000018	-0.0000022	-0.0000009
25	-0.00000229	0.0000031	0.0000010	0.0000017	0.0000003	0.0
26	-0.00000111	-0.0000046	0.0000002	0.0000003	0.0000008	0.0000003
27	0.00000066	-0.0000033	-0.0000003	-0.0000003	0.0000002	0.0000001
28	0.00000054	-0.0000006	-0.0000003	-0.0000002	-0.0000001	-0.0000001
29	0.00000001	0.0000012	0.0000001	0.0	-0.0000001	0.0
30	-0.00000013	0.0000006	0.0	0.0	-0.0000001	-0.0000001
31	-0.00000009	-0.0000002	-0.0000001	0.0	-0.0000001	0.0000001
SUMS	43.29290610	21.3553676	116.2427372	32.6428535	67.0600079	21.5918734

DAYS 245 THRU 276 JD 2444483.5 TO 2444515.5 DATES SEPT 1 THRU OCT 2

A = 16.00000000 B = -16.31250000

TERM	R A H	DEC DEG	H P "	X E RAD	Y E RAD	Z E RAD
0	35.66066955	15.3596637	114.6012477	-6.9900576	43.3013215	15.7717212
1	14.07531286	-0.8040207	0.6971338	6.8341446	-1.3771869	-0.8339499
2	0.40171161	16.7080748	0.5296500	4.6483603	49.4868622	17.2343356
3	0.15461389	3.6793991	-2.7057399	-48.6040776	3.1515879	4.1763059
4	-0.21208501	-8.7571657	-0.7213657	-3.3176251	-26.3315531	-9.1156574
5	-0.00359572	-1.6929298	0.5525758	11.2296820	-2.0394555	-1.4427202
6	0.05775360	0.7834810	0.4680976	1.6845175	3.2873588	1.0572491
7	-0.02648856	0.6388384	0.0294482	-0.6597636	0.9648454	0.3854730
8	-0.01953831	0.1812656	-0.1352665	-0.5389986	0.0490285	0.0516679
9	0.00416928	-0.1456730	-0.0539323	-0.1643881	-0.2189836	-0.0673292
10	0.00676266	-0.0788737	0.0095569	0.0718661	-0.1133695	-0.0447862
11	0.00218288	0.0137673	0.0198751	0.0690588	0.0096726	-0.0009480
12	-0.00188344	0.0188165	0.0071376	0.0095120	0.0312196	0.0104747
13	-0.00116106	0.0022545	-0.0029135	-0.0128681	0.0098107	0.0042982
14	0.00037108	-0.0041204	-0.0034591	-0.0073515	-0.0034717	-0.0007651
15	0.00034754	-0.0013070	-0.0006766	-0.0000230	-0.0038156	-0.0013537
16	-0.00004123	0.0008856	0.0007177	0.0018502	-0.0008271	-0.0004115
17	-0.00012120	0.0003755	0.0005252	0.0008400	0.0006430	0.0001756
18	-0.00001011	-0.0001667	0.0000293	-0.0001316	0.0005072	0.0001886
19	0.00004690	-0.0001002	-0.0001436	-0.0002829	0.0000455	0.0000338
20	0.00001280	0.0000422	-0.0000763	-0.0000868	-0.0001163	-0.0000358
21	-0.00001424	0.0000346	0.0000081	0.0000380	-0.0000631	-0.0000249
22	-0.00000768	-0.0000183	0.0000269	0.0000408	0.0000036	-0.0000013
23	0.00000291	-0.0000168	0.0000102	0.0000079	0.0000194	0.0000065
24	0.00000342	0.0000060	-0.0000035	-0.0000084	0.0000076	0.0000032
25	-0.00000026	0.0000083	-0.0000048	-0.0000057	-0.0000023	-0.0000005
26	-0.00000125	0.0000003	-0.0000011	0.0000001	-0.0000032	-0.0000011
27	-0.00000014	-0.0000033	0.0000011	0.0000015	-0.0000006	-0.0000003
28	0.00000038	-0.0000011	0.0000008	0.0000006	0.0000007	0.0000002
29	0.00000014	0.0000007	0.0000001	-0.0000002	0.0000004	0.0000002
30	-0.00000014	0.0000007	-0.0000003	-0.0000002	0.0	-0.0000001
31	-0.00000009	0.0	-0.0000002	-0.0000001	-0.0000002	-0.0000001
SUMS	50.09901306	25.9025181	113.2924587	-35.7457487	70.2040859	27.1839484

CHEBYSHEV APPROXIMATION OF LUNAR COORDINATES FOR YEAR 1980

DAYS 275 THRU 306 JD 2444513.5 TO 2444545.5 DATES OCT 1 THRU NOV 1

A = 16.00000000 B = -18.18750000

TERM	R A	DEC	H P	X	Y	Z
	H	DEG	'	E RAD	E RAD	E RAD
0	40.45432097	13.8307601	113.3633516	-35.1999589	34.0270479	14.4153756
1	14.08391207	0.6605727	0.7895803	6.7272582	2.7299007	0.6895573
2	0.49182004	15.7595767	-0.7750073	-26.1860190	41.9836205	16.7006960
3	-0.03651265	-6.0289609	-2.8336945	-41.8217005	-23.8234675	-5.8595291
4	-0.21833696	-8.7926973	-0.0114358	13.3287977	-23.0347851	-9.1064826
5	0.02083877	0.5750670	0.7797409	10.9958133	4.6620387	0.9466352
6	-0.01766290	1.6767278	0.3907347	-0.8106352	4.0509276	1.5041389
7	-0.02333586	0.5092760	-0.1066191	-1.5566662	0.2852845	0.2052315
8	0.01699604	-0.1996520	-0.1721453	-0.4355708	-0.5041756	-0.1525652
9	0.01441100	-0.1835211	-0.0223130	0.1404639	-0.2745850	-0.1077208
10	-0.00069207	-0.0199476	0.0386785	0.1607638	0.0111104	-0.0064556
11	-0.00510747	0.0235843	0.0218746	0.0264230	0.0730195	0.0244902
12	-0.00136670	0.0150716	-0.0024967	-0.0319806	0.0244366	0.0108422
13	0.00090492	0.0035167	-0.0077907	-0.0183941	-0.0104436	-0.0025536
14	0.00041162	-0.0013360	-0.0024100	0.0018305	-0.0099732	-0.0036983
15	-0.00004420	-0.0023054	0.0014683	0.0053760	-0.0008903	-0.0006688
16	0.00000998	-0.0010361	0.0013451	0.0015243	0.0022687	0.0007164
17	0.00003300	0.0003840	0.0000763	-0.0008581	0.0011054	0.0004526
18	-0.00003599	0.0004907	-0.0003873	-0.0007481	-0.0001964	-0.0000226
19	-0.00003967	0.0000329	-0.0001800	-0.0000493	-0.0003830	-0.0001345
20	0.00000464	-0.0001214	0.0000480	0.0001910	-0.0000919	-0.0000453
21	0.00001774	-0.0000247	0.0000764	0.0000874	0.0000732	0.0000206
22	0.00000384	0.0000293	0.0000160	-0.0000211	0.0000543	0.0000210
23	-0.00000396	0.0000051	-0.0000180	-0.0000332	-0.0000005	0.0000020
24	-0.00000186	-0.0000110	-0.0000123	-0.0000062	-0.0000157	-0.0000055
25	0.00000036	-0.0000029	0.0000008	0.0000072	-0.0000056	-0.0000025
26	0.00000018	0.0000039	0.0000041	0.0000043	0.0000024	0.0000007
27	-0.00000010	0.0000018	0.0000013	-0.0000004	0.0000024	0.0000010
28	0.00000013	-0.0000009	-0.0000008	-0.0000013	0.0000002	0.0000001
29	0.00000016	-0.0000006	-0.0000007	-0.0000005	-0.0000005	-0.0000002
30	-0.00000005	0.0	-0.0000001	0.0000002	-0.0000004	-0.0000001
31	-0.00000008	0.0000001	0.0000002	0.0000003	0.0000001	0.0
SUMS	54.78054494	17.8254828	111.4524855	-74.6741024	40.1918788	19.2582966

DAYS 306 THRU 337 JD 2444544.5 TO 2444576.5 DATES NOV 1 THRU DEC 2

A = 16.00000000 B = -20.12500000

TERM	R A	DEC	H P	X	Y	Z
	H	DEG	'	E RAD	E RAD	E RAD
0	46.75103224	4.3184311	112.0048451	-55.4674450	2.2242303	4.5115410
1	14.09130020	2.5090668	0.5893207	2.0817843	6.7695231	2.4633706
2	0.31753885	5.9185429	-2.2730086	-50.3902411	9.1313246	6.6611540
3	-0.32042744	-14.8054295	-1.7747498	-9.6376485	-44.5317926	-15.4893831
4	-0.14881310	-3.7053522	0.9891738	27.4206535	-5.4686353	-3.8406873
5	-0.00609263	3.9641771	0.7716638	3.4601781	11.3970398	3.8791821
6	-0.00288551	1.2908559	0.0264284	-4.5354604	1.7346371	0.9389261
7	0.05335607	-0.5721017	-0.2745956	-1.0896609	-1.5038677	-0.4685473
8	0.02042123	-0.4092006	-0.0863564	0.5191187	-0.5639429	-0.2398943
9	-0.01952371	-0.0073059	0.0684045	0.3297409	0.1488660	0.0312888
10	-0.01162543	0.0835650	0.0410343	-0.0250335	0.1608970	0.0600174
11	0.00337714	0.0534450	-0.0098284	-0.0854095	0.0091279	0.0091504
12	0.00388800	0.0000884	-0.0147115	-0.0173406	-0.0386429	-0.0128202
13	0.00041706	-0.0231240	-0.0010981	0.0181367	-0.0126863	-0.0058360
14	-0.00056132	-0.0092496	0.0041927	0.0092274	0.0071891	0.0019757
15	-0.00052459	0.0053243	0.0015398	-0.0025910	0.0051676	0.0020500
16	-0.00022552	0.0047227	-0.0008862	-0.0031140	-0.0006485	-0.0000231
17	0.00016431	-0.0001433	-0.0007361	-0.0000867	-0.0015576	-0.0005590
18	0.00020101	-0.0013317	0.0000775	0.0008272	-0.0002241	-0.0001374
19	0.00000136	-0.0004638	0.0002546	0.0002406	0.0003720	0.0001186
20	-0.00007792	0.0001255	0.0000456	-0.0001683	0.0001609	0.0000698
21	-0.00002661	0.0002101	-0.0000681	-0.0001126	-0.0000627	-0.0000153
22	0.00001412	0.0000896	-0.0000332	0.0000181	-0.0000623	-0.0000239
23	0.00001378	-0.0000357	0.0000126	0.0000369	0.0000015	-0.0000018
24	0.00000318	-0.0000566	0.0000140	0.0000045	0.0000182	0.0000062
25	-0.00000307	-0.0000114	0.0000001	-0.0000093	0.0000044	0.0000021
26	-0.00000355	0.0000159	-0.0000045	-0.0000038	-0.0000040	-0.0000013
27	-0.00000059	0.0000101	-0.0000013	0.0000016	-0.0000024	-0.0000009
28	0.00000137	-0.0000004	0.0000011	0.0000015	0.0000005	0.0000001
29	0.00000083	-0.0000033	0.0000007	-0.0000001	0.0000009	0.0000003
30	-0.00000020	-0.0000018	0.0	-0.0000005	0.0000001	0.0
31	-0.00000039	0.0000002	-0.0000002	-0.0000001	-0.0000002	0.0
SUMS	60.73093917	-1.3851409	110.0609313	-87.4143559	-20.5335685	-1.4990777

DAYS 336 THRU 367 JD 2444574.5 TO 2444606.5 DATES DEC 1 THRU JAN 1

A = 16.00000000 B = -22.00000000

TERM	R A	DEC	H P	X	Y	Z
	H	DEG	'	E RAD	E RAD	E RAD
0	51.20436466	-4.5359168	111.7346408	-50.7559782	-23.8936687	-5.0937671
1	14.08514127	2.7651368	0.2864110	-2.8243700	6.6608826	2.7457239
2	0.05314651	-3.7969844	-2.5222804	-47.5525830	-19.6323064	-3.7859551
3	-0.36358346	-15.4513027	-0.4983779	18.9394673	-41.0710480	-16.3169374
4	-0.06146265	2.0065967	1.2442378	26.0567392	10.6324608	1.9962963
5	0.00536651	4.4844379	0.4095082	-4.6357264	10.8963426	4.2888998
6	0.06558846	-0.2965782	-0.1231130	-4.7104506	-1.6440838	-0.2569208
7	0.05704513	-0.9153214	-0.2061565	0.4988502	-1.7252382	-0.6622529
8	-0.02951078	-0.0732283	-0.0147838	0.7561934	0.1238029	-0.0097203
9	-0.02661301	0.1498136	0.0667233	0.0042660	0.3016613	0.1093317
10	0.00774960	0.0955697	0.0135972	-0.1366978	0.0264160	0.0195040
11	0.00857781	0.0026436	-0.0174010	-0.0295860	-0.0547746	-0.0177848
12	-0.00036122	-0.0485884	-0.0064679	0.0234457	-0.0192079	-0.0086862
13	-0.00204436	-0.0151307	0.0036720	0.0130445	0.0089302	0.0023076
14	-0.00100955	0.0165633	0.0024824	-0.0032857	0.0070007	0.0027851
15	0.00020750	0.0082863	-0.0004998	-0.0041064	-0.0010159	-0.0000735
16	0.00070351	-0.0036160	-0.0008255	0.0001366	-0.0020293	-0.0007485
17	0.00013141	-0.0032574	-0.0000377	0.0010947	-0.0000839	-0.0001093
18	-0.00029315	-0.0000058	0.0002412	0.0001543	0.0005098	0.0001747
19	-0.00011560	0.0010093	0.0000623	-0.0002543	0.0001127	0.0000593
20	0.00007870	0.0004870	-0.0000606	-0.0000873	-0.0001106	-0.0000342
21	0.00005946	-0.0002162	-0.0000308	0.0000493	-0.0000509	-0.0000220
22	-0.00000485	-0.0002969	0.0000122	0.0000328	0.0000188	0.0000046
23	-0.00002333	-0.0000004	0.0000116	-0.0000063	0.0000174	0.0000068
24	-0.00000935	0.0001161	-0.0000013	-0.0000102	-0.0000014	0.0000002
25	0.00000669	0.0000323	-0.0000037	-0.0000005	-0.0000052	-0.0000017
26	0.00000696	-0.0000305	-0.0000004	0.0000028	-0.0000008	-0.0000004
27	-0.00000076	-0.0000216	0.0000010	0.0000007	0.0000013	0.0000004
28	-0.00000315	0.0000025	0.0000004	-0.0000006	0.0000005	0.0000003
29	-0.00000061	0.0000094	-0.0000002	-0.0000004	-0.0000003	0.0
30	0.00000100	0.0000029	-0.0000001	0.0000001	-0.0000002	0.0
31	0.00000057	-0.0000028	0.0	0.0	0.0	0.0000001
SUMS	65.00313992	-15.6097911	110.3715608	-64.3596661	-59.3854685	-16.9879194

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1980
MERCURY AND VENUS

DAYS 1 THRU 95 JD 2444239.5 TO 2444334.5 DATES JAN 1 THRU APR 4

A = 47.50000000 B = -1.02105263

TERM	MERCURY R A	MERCURY DEC	MERCURY DISTANCE	VENUS R A	VENUS DEC	VENUS DISTANCE
	H	DEG	AU	H	DEG	AU
0	42.8368917	-26.179079	2.1359131	48.9825218	5.581965	2.0950774
1	2.5176216	10.234106	-0.3767459	3.4399835	22.192685	-0.3159943
2	-1.1598757	-4.665942	0.0901600	-0.0628360	-0.572267	-0.0161830
3	0.1745437	-2.563208	0.1849248	0.0264044	-0.857313	0.0006732
4	0.4115444	2.979593	-0.0028078	-0.0055704	0.026335	0.0002089
5	0.0762393	1.493280	-0.0499341	-0.0022259	0.002528	0.0000325
6	-0.1161255	-0.611452	-0.0102116	-0.0000797	0.001104	0.0000032
7	-0.0681098	-0.693164	0.0143245	-0.0000879	0.000249	-0.0000052
8	0.0207530	0.010008	0.0061526	-0.0000208	-0.000226	0.0000180
9	0.0325838	0.254567	-0.0035336	0.0000626	0.000226	0.0000076
10	0.0029877	0.077666	-0.0026666	0.0000236	0.000131	-0.0000117
11	-0.0111605	-0.066313	0.0006602	-0.0000217	-0.000081	-0.0000034
12	-0.0048600	-0.050728	0.0009412	-0.0000077	-0.000042	0.0000034
13	0.0024160	0.005246	-0.0000560	0.0000029	0.000014	0.0000007
14	0.0026228	0.020005	-0.0002753	0.0000013	0.000012	-0.0000003
15	0.0000907	0.006405	-0.0000115	-0.0000008	-0.000006	0.0
16	-0.0009092	-0.004386	0.0000666	-0.0000004	0.0	0.0000002
17	-0.0004022	-0.004578	-0.0000017	0.0000014	0.000003	0.0000001
18	0.0001590	-0.000642	-0.0000151	-0.0000002	-0.000001	-0.0000004
19	0.0002264	0.001642	0.0000088	-0.0000005	0.000001	-0.0000002
20	0.0000484	0.001215	0.0000057	0.0000003	0.000001	0.0000003
21	-0.0000711	-0.000148	-0.0000073	-0.0000003	-0.000002	0.0000001
22	-0.0000576	-0.000683	-0.0000040	-0.0000002	-0.000001	-0.0000001
23	0.0000038	-0.000261	0.0000039	0.0000003	-0.000001	-0.0000001
24	0.0000289	0.000221	0.0000028	0.0000001	-0.000002	0.0
25	0.0000117	0.000225	-0.0000015	0.0	0.000001	0.0
26	-0.0000086	-0.000015	-0.0000017	0.0	0.0	0.0
27	-0.0000092	-0.000110	0.0000004	-0.0000002	0.000001	0.0
28	0.0000004	-0.000037	0.0000008	0.0000001	0.000002	0.0
29	0.0000044	0.000034	0.0	0.0	0.0	0.0
30	0.0000013	0.000031	-0.0000003	-0.0000002	-0.000002	0.0
31	-0.0000012	-0.000002	0.0	0.0000001	0.000001	0.0
32	-0.0000011	-0.000014	0.0000001	0.0000001	0.000001	0.0
33	0.0000001	-0.000003	0.0	0.0000002	0.000001	0.0
34	0.0000005	0.000003	0.0	-0.0000001	-0.000001	0.0
35	0.0000001	0.000005	0.0	-0.0000001	-0.000001	0.0
36	-0.0000002	0.000001	0.0	0.0000001	0.0	0.0
37	-0.0000002	0.0	0.0	-0.0000001	-0.000001	0.0
SUMS	44.7171876	-19.756512	1.9868915	52.3781496	26.375314	1.7638269

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1980
MERCURY AND VENUS

DAYS 92 THRU 186 JD 2444330.5 TO 2444425.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.93684211

TERM	MERCURY R A H	MERCURY DEC DEG	MERCURY DISTANCE AU	VENUS R A H	VENUS DEC DEG	VENUS DISTANCE AU
0	55.6026687	22.721076	1.8866920	10.1846453	47.034492	0.9349336
1	4.8396947	14.754238	-0.1943693	0.6443888	-2.844149	-0.2224222
2	-0.3998184	-8.123827	-0.2723891	-0.9024808	-3.459100	0.0783214
3	-0.5816916	-2.498531	0.0577183	0.0336605	0.620713	0.0229577
4	-0.0728440	1.961764	0.0576629	0.1382406	0.251221	0.0008856
5	0.0616088	0.569272	-0.0073143	0.0407204	0.135198	-0.0019321
6	0.0147039	-0.312825	-0.0129495	-0.0073519	0.041987	-0.0008172
7	-0.0187402	-0.139733	0.0033491	-0.0103769	-0.020590	-0.0000306
8	-0.0009694	0.093998	0.0043886	-0.0028330	-0.022308	0.0001364
9	0.0071948	0.039613	-0.0012339	0.0010908	-0.005267	0.0000482
10	0.0007941	-0.032601	-0.0014894	0.0009716	0.003041	-0.0000156
11	-0.0022903	-0.013366	0.0004649	0.0001007	0.002581	-0.0000076
12	-0.0001747	0.011614	0.0005240	-0.0001351	0.000449	0.0000022
13	0.0008283	0.004511	-0.0001905	-0.0000584	-0.000397	0.0000004
14	0.0000249	-0.004428	-0.0001938	0.0000016	-0.000275	-0.0000008
15	-0.0003212	-0.001581	0.0000793	0.0000090	-0.000026	-0.0000002
16	-0.0000009	0.001753	0.0000734	0.0000032	0.000048	0.0000003
17	0.0001247	0.000576	-0.0000339	0.0	0.000030	-0.0000001
18	-0.0000056	-0.000705	-0.0000281	-0.0000040	0.000001	0.0000001
19	-0.0000506	-0.000211	0.0000148	-0.0000003	-0.000015	0.0000004
20	0.0000050	0.000288	0.0000109	0.0000050	-0.000005	-0.0000001
21	0.0000213	0.000080	-0.0000065	0.0000010	0.000007	-0.0000003
22	-0.0000026	-0.000120	-0.0000044	-0.0000029	0.000002	0.0
23	-0.0000091	-0.000027	0.0000028	-0.0000011	-0.000005	0.0000001
24	0.0000012	0.000048	0.0000017	0.0000008	-0.000005	0.0
25	0.0000035	0.000011	-0.0000012	0.0000007	0.000001	0.0
26	-0.0000007	-0.000020	-0.0000007	-0.0000003	0.000001	0.0
27	-0.0000015	-0.000003	0.0000006	-0.0000001	0.0	0.0
28	0.0000004	0.000012	0.0000003	0.0000003	0.000002	0.0
29	0.0000007	0.000001	-0.0000002	-0.0000001	0.000003	0.0
30	-0.0000004	-0.000005	-0.0000001	-0.0000004	0.000001	0.0
31	-0.0000001	-0.000001	0.0000001	0.0	-0.000002	0.0
32	0.0000001	0.000001	0.0	0.0000003	0.000002	0.0
33	0.0000001	-0.000001	-0.0000001	-0.0000001	0.0	0.0
34	-0.0000001	-0.000001	0.0	-0.0000003	-0.000002	0.0
35	0.0000001	-0.000001	0.0	-0.0000001	0.000001	0.0
36	0.0000002	0.0	0.0	-0.0000001	-0.000002	0.0
37	0.0	-0.000001	0.0	0.0	0.0	0.0
SUMS	59.4507541	29.030868	1.5207787	10.1205947	41.737633	0.8120596

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1980
MERCURY AND VENUS

DAYS 183 THRU 277 JD 2444421.5 TO 2444516.5 DATES JULY 1 THRU OCT 3

A = 47.50000000 B = -4.85263158

TERM	MERCURY R A H	MERCURY DEC DEG	MERCURY DISTANCE AU	VENUS R A H	VENUS DEC DEG	VENUS DISTANCE AU
0	20.1508585	14.748836	1.9883731	14.1794425	34.371102	1.3136485
1	3.6383024	-17.096790	0.3738980	2.6375854	-2.313409	0.3492321
2	0.9202776	-7.608744	-0.1832805	0.4615629	-2.076002	0.0082879
3	-0.5893100	0.583829	-0.1260187	-0.1337695	-1.027811	-0.0073970
4	-0.0096849	2.117042	0.0623845	0.0194789	0.256625	0.0018462
5	0.1588618	-0.485761	0.0093227	-0.0021030	-0.002015	-0.0004301
6	-0.0559300	-0.385570	-0.0171772	0.0000819	-0.006935	0.0000842
7	-0.0196322	0.196163	-0.0001356	0.0004340	0.003231	0.0000008
8	0.0134518	0.075703	0.0047224	-0.0001259	-0.001596	-0.0000121
9	0.0029348	-0.059721	-0.0001672	0.0000030	0.000477	-0.0000144
10	-0.0023334	-0.020449	-0.0016069	-0.0000830	-0.000058	0.0000067
11	-0.0020333	0.021877	0.0001678	0.0000472	0.000102	0.0000071
12	0.0011918	0.005860	0.0006055	0.0000134	-0.000035	-0.0000028
13	0.0008425	-0.008904	-0.0001341	-0.0000136	-0.000030	-0.0000016
14	-0.0007215	-0.001209	-0.0002180	-0.0000035	0.000025	0.0000009
15	-0.0001805	0.003558	0.0000783	0.0000030	-0.000002	0.0000004
16	0.0003016	0.000066	0.0000751	0.0000003	-0.000008	0.0
17	0.0000192	-0.001388	-0.0000382	0.0000008	-0.000009	0.0
18	-0.0001065	0.000106	-0.0000258	0.0000024	0.0	-0.0000004
19	0.0000003	0.000542	0.0000176	-0.0000022	0.000009	-0.0000002
20	0.0000409	-0.000096	0.0000087	-0.0000023	0.000007	0.0000003
21	-0.0000027	-0.000214	-0.0000082	0.0000014	-0.000003	0.0000001
22	-0.0000175	0.000063	-0.0000028	0.0000009	-0.000002	-0.0000002
23	0.0000032	0.000081	0.0000037	-0.0000006	0.000005	0.0
24	0.0000068	-0.000034	0.0000007	-0.0000005	0.000001	0.0000001
25	-0.0000024	-0.000028	-0.0000016	0.0000002	0.000001	0.0
26	-0.0000027	0.000021	-0.0000001	0.0000003	-0.000002	0.0
27	0.0000014	0.000008	0.0000007	-0.0000002	-0.000004	0.0
28	0.0000009	-0.000010	-0.0000001	0.0	-0.000002	0.0
29	-0.0000007	-0.000003	-0.0000003	0.0000001	0.000002	0.0
30	-0.0000003	0.000004	0.0000001	0.0000001	0.000001	0.0
31	0.0000002	0.000003	0.0000001	0.0	-0.000002	0.0
32	0.0000002	-0.000004	0.0	-0.0000001	0.000001	0.0
33	-0.0000001	0.0	0.0	0.0	-0.000001	0.0
34	-0.0000001	-0.000001	0.0	-0.0000001	0.0	0.0
35	0.0000001	-0.000001	0.0	0.0	-0.000001	0.0
36	0.0000003	-0.000001	0.0	0.0000001	-0.000001	0.0
37	-0.0000001	0.000001	0.0	0.0000001	0.000001	0.0
SUMS	24.2071374	-7.915165	2.1108437	17.1625544	29.203662	1.6652565

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1980
MERCURY AND VENUS

DAYS 275 THRU 369 JD 2444513.5 TO 2444608.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.78947368

TERM	MERCURY R A H	MERCURY DEC DEG	MERCURY DISTANCE AU	VENUS R A H	VENUS DEC DEG	VENUS DISTANCE AU
0	31.7040578	-37.988381	2.2857007	26.9982188	-11.575695	2.5500324
1	2.2739625	-4.385185	0.2576528	3.7227294	-18.608468	0.2691867
2	0.9470704	-2.509301	0.1864129	0.0990312	1.076440	-0.0194510
3	0.3843283	-1.117240	-0.1667128	0.0265060	0.922485	-0.0005615
4	-0.3971051	3.410885	-0.0360929	-0.0026101	0.015858	0.0001177
5	0.0019589	-0.111689	0.0590060	-0.0021091	-0.007883	0.0000038
6	0.1634942	-1.328881	-0.0050077	-0.0000823	-0.001515	-0.0000004
7	-0.0624215	0.439340	-0.0208243	0.0000517	-0.000694	0.0000062
8	-0.0512150	0.466726	0.0079220	0.0000390	-0.000140	-0.0000175
9	0.0474972	-0.354287	0.0059597	-0.0000420	0.000226	-0.0000082
10	0.0063421	-0.106849	-0.0050611	-0.0000143	0.000091	0.0000112
11	-0.0246596	0.207740	-0.0009344	0.0000197	-0.000108	0.0000035
12	0.0061134	-0.018660	0.0024466	0.0000031	-0.000020	-0.0000033
13	0.0095121	-0.096637	-0.0003729	-0.0000035	0.000022	-0.0000005
14	-0.0064828	0.043534	-0.0009474	0.0000008	-0.000006	0.0000004
15	-0.0021758	0.033114	0.0004732	-0.0000010	0.0	0.0
16	0.0039692	-0.034107	0.0002645	0.0000001	-0.000004	-0.0000001
17	-0.0004364	-0.004380	-0.0003010	-0.0000006	0.000006	-0.0000004
18	-0.0017829	0.019112	-0.0000172	-0.0000014	0.000013	0.0000001
19	0.0008948	-0.004878	0.0001430	0.0000020	-0.000009	0.0000004
20	0.0005407	-0.008050	-0.0000418	0.0000016	-0.000011	-0.0000001
21	-0.0006517	0.005573	-0.0000511	-0.0000018	0.000007	-0.0000002
22	-0.0003184	0.002061	0.0000376	-0.0000008	0.000002	0.0000001
23	0.0003323	-0.003701	0.0000102	0.0000006	-0.000003	0.0000001
24	-0.0001198	0.000346	-0.0000213	0.0000002	-0.000001	0.0
25	-0.0001197	0.001808	0.0000031	-0.0000003	0.000002	0.0
26	0.0001073	-0.000882	0.0000089	-0.0000001	0.000001	0.0
27	0.0000183	-0.000606	-0.0000049	0.0000002	0.0	0.0
28	-0.0000616	0.000704	-0.0000024	0.0000002	-0.000001	0.0
29	0.0000151	0.000044	0.0000033	0.0	0.0	0.0
30	0.0000250	-0.000390	-0.0000001	-0.0000002	0.000002	0.0
31	-0.0000176	0.000131	-0.0000016	0.0000002	0.000001	0.0
32	-0.0000056	0.000158	0.0000007	0.0	-0.000001	0.0
33	0.0000113	-0.000133	0.0000005	-0.0000002	-0.000002	0.0
34	-0.0000016	-0.000030	-0.0000005	0.0	-0.000001	0.0
35	-0.0000054	0.000084	0.0	0.0000002	-0.000001	0.0
36	0.0000028	-0.000018	0.0000003	0.0	0.000003	0.0
37	0.0000015	-0.000040	-0.0000001	0.0	0.000001	0.0
SUMS	35.0029747	-43.442965	2.5696505	30.8417373	-28.179403	2.7993194

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1980
MARS AND JUPITER

DAYS 1 THRU 95 JD 2444239.5 TO 2444334.5 DATES JAN 1 THRU APR 4

A = 47.50000000 B = -1.02105263

TERM	MARS R A (H)	MARS DEC (DEG)	MARS DISTANCE (AU)	JUPITER R A (H)	JUPITER DEC (DEG)	JUPITER DISTANCE (AU)
0	21.2886963	24.875374	1.5899321	21.0842682	21.001115	9.1513068
1	-0.6893847	4.047879	-0.0759599	-0.3118343	1.913898	-0.0962644
2	-0.1388227	0.078165	0.1044347	-0.0228360	0.068201	0.1612640
3	0.1233392	-0.811784	0.0049676	0.0227361	-0.139438	0.0037877
4	0.0192713	-0.022145	-0.0042390	0.0010316	-0.001556	-0.0035116
5	-0.0089289	0.076260	-0.0005051	-0.0006308	0.004303	-0.0000978
6	-0.0026360	0.005555	0.0002445	-0.0000490	0.000059	0.0000619
7	0.0006864	-0.008418	0.0000582	0.0000209	-0.000161	0.0000034
8	0.0003287	-0.001136	-0.0000307	-0.0000003	0.000006	-0.0000153
9	-0.0001352	0.001333	-0.0000048	-0.0000149	0.000065	0.0000024
10	-0.0000356	0.000101	0.0000189	0.0000017	-0.000011	0.0000174
11	0.0000734	-0.000431	-0.0000004	0.0000111	-0.000051	-0.0000017
12	0.0000063	0.000022	-0.0000086	-0.0000002	0.000004	-0.0000078
13	-0.0000268	0.000143	0.0000001	-0.0000033	0.000015	0.0000005
14	-0.0000018	-0.000014	0.0000020	0.0000008	-0.000003	0.0000016
15	0.0000044	-0.000024	0.0	-0.0000004	0.000004	-0.0000001
16	0.0000001	0.000002	-0.0000003	-0.0000005	0.000002	-0.0000002
17	-0.0000017	0.000009	0.0	-0.0000003	0.000001	0.0000001
18	-0.0000005	-0.000002	0.0000004	-0.0000006	0.000001	0.0000004
19	0.0000037	-0.000019	-0.0000001	0.0000014	-0.000010	-0.0000001
20	0.0000009	0.000001	-0.0000005	0.0000011	-0.000003	-0.0000005
21	-0.0000032	0.000018	0.0	-0.0000012	0.000010	0.0
SUMS	20.5924336	28.240889	1.6189091	20.7727011	22.846451	9.2165467

DAYS 92 THRU 186 JD 2444330.5 TO 2444425.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.93684211

TERM	MARS R A (H)	MARS DEC (DEG)	MARS DISTANCE (AU)	JUPITER R A (H)	JUPITER DEC (DEG)	JUPITER DISTANCE (AU)
0	21.3541572	20.079927	2.3292668	20.6507508	23.379420	10.5340420
1	0.9635217	-7.244840	0.3749873	0.1757211	-1.126500	0.6981427
2	0.2095336	-1.224167	0.0013802	0.0945365	-0.539022	0.0112719
3	-0.0354662	0.139149	-0.0059625	-0.0057326	0.029143	-0.0172940
4	0.0047636	-0.014364	0.0009833	-0.0009316	0.003151	0.0008736
5	0.0000716	0.003806	-0.0001354	0.0002408	-0.000931	0.0000533
6	-0.0002227	-0.000273	0.0000143	-0.0000298	0.000190	-0.0000142
7	0.0000659	-0.000043	-0.0000037	-0.0000018	-0.000004	0.0000005
8	-0.0000638	0.000278	0.0000090	-0.0000078	0.000036	0.0000097
9	0.0000390	-0.000190	0.0000162	0.0000078	-0.000033	0.0000149
10	0.0000385	-0.000150	-0.0000100	0.0000082	-0.000032	-0.0000114
11	-0.0000285	0.000108	-0.0000082	-0.0000072	0.000030	-0.0000087
12	-0.0000105	0.000043	0.0000040	-0.0000030	0.000008	0.0000049
13	0.0000076	-0.000021	0.0000023	0.0000018	-0.000007	0.0000026
14	0.0000027	-0.000015	-0.0000007	0.0000010	-0.000008	-0.0000010
15	0.0000001	-0.000007	-0.0000006	0.0000009	-0.000005	-0.0000007
16	-0.0000009	0.000004	0.0000001	-0.0000004	0.000004	0.0000001
17	0.0000011	-0.000009	0.0	0.0000004	-0.000003	0.0000001
18	-0.0000005	0.000005	-0.0000003	-0.0000003	0.000005	-0.0000003
19	-0.0000026	0.000011	0.0000002	-0.0000017	0.000007	0.0000003
20	0.0000015	-0.000010	0.0000003	0.0000007	-0.000008	0.0000003
21	0.0000018	-0.000012	-0.0000002	0.0000014	-0.000006	-0.0000002
SUMS	22.4964102	11.739230	2.7005424	20.9145552	21.745435	11.2270864

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1980
MARS AND JUPITER

DAYS 183 THRU 277 JD 2444421.5 TO 2444516.5 DATES JULY 1 THRU OCT 3

A = 47.50000000 B = -4.85263158

TERM	MARS R A H	MARS DEC DEG	MARS DISTANCE AU	JUPITER R A H	JUPITER DEC DEG	JUPITER DISTANCE AU
0	26.9454351	-17.390897	3.5809288	22.2464590	13.457850	12.5108416
1	1.8717498	-11.230577	0.2620009	0.5981133	-3.747081	0.2442213
2	0.0916653	0.241748	-0.0214732	0.0175925	-0.136932	-0.1076855
3	0.0037077	0.164374	0.0001358	-0.0055782	0.037015	-0.0040368
4	0.0004149	0.008814	0.0001283	0.0001305	0.000555	0.0007379
5	-0.0002279	0.000425	-0.0000040	-0.0000349	0.000108	0.0000155
6	0.0000008	-0.000135	0.0000069	0.0000052	-0.000031	0.0000089
7	-0.0000192	0.000092	0.0000028	-0.0000014	0.000007	0.0000035
8	0.0000138	-0.000015	0.0000176	0.0000084	-0.000042	0.0000087
9	0.0000367	-0.000197	-0.0000063	0.0000058	-0.000029	-0.0000164
10	-0.0000116	0.000023	-0.0000141	-0.0000078	0.000032	-0.0000091
11	-0.0000168	0.000085	0.0000030	-0.0000027	0.000017	0.0000091
12	0.0000034	-0.000008	0.0000048	0.0000020	-0.000007	0.0000035
13	0.0000045	-0.000027	-0.0000011	0.0000009	-0.000005	-0.0000029
14	-0.0000027	0.000014	-0.0000012	-0.0000019	0.000011	-0.0000008
15	-0.0000014	0.000008	0.0000003	-0.0000005	0.000001	0.0000008
16	0.0000008	0.0	0.0000002	0.0000008	-0.000004	0.0000002
17	-0.0000002	0.000002	0.0000002	0.0	-0.000001	0.0000001
18	0.0000017	-0.000011	0.0000002	0.0000012	-0.000009	-0.0000001
19	0.0000009	-0.000010	-0.0000003	0.0000005	0.0	-0.0000004
20	-0.0000019	0.000012	-0.0000002	-0.0000015	0.000010	0.0
21	-0.0000008	0.000003	0.0000002	-0.0000004	0.0	0.0000003
SUMS	28.9127529	-28.206277	3.8217296	22.8566908	9.611465	12.6440994

DAYS 275 THRU 369 JD 2444513.5 TO 2444608.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.78947368

TERM	MARS R A H	MARS DEC DEG	MARS DISTANCE AU	JUPITER R A H	JUPITER DEC DEG	JUPITER DISTANCE AU
0	35.5906441	-44.108139	4.3172035	24.4302764	-0.243536	11.8421959
1	2.5604384	-0.880998	0.1256320	0.4752187	-2.933307	-0.5666768
2	0.0466516	2.338125	-0.0120180	-0.0530530	0.370994	-0.0774188
3	-0.0174212	0.089622	0.0011640	-0.0075929	0.050096	0.0104754
4	-0.0012439	-0.032640	-0.0000087	-0.0002244	0.000184	0.0012061
5	0.0004397	-0.002671	0.0000065	0.0000423	-0.000319	0.0000207
6	0.0000620	0.000485	0.0	0.0000120	-0.000061	-0.0000147
7	-0.0000124	0.000165	0.0000100	0.0000037	-0.000021	-0.0000003
8	0.0000328	-0.000032	0.0000008	0.0000003	-0.000007	-0.0000156
9	0.0000029	-0.000035	-0.0000188	-0.0000101	0.000053	-0.0000028
10	-0.0000275	0.000042	-0.0000008	-0.0000015	0.000016	0.0000166
11	0.0000005	-0.000003	0.0000092	0.0000075	-0.000040	0.0000021
12	0.0000096	-0.000021	0.0000002	0.0000011	-0.000010	-0.0000068
13	-0.0000001	0.000010	-0.0000022	-0.0000017	0.000008	-0.0000005
14	-0.0000009	-0.000006	0.0000002	0.0000001	-0.000001	0.0000013
15	-0.0000008	-0.000005	0.0000002	-0.0000008	0.000006	-0.0000001
16	0.0	0.000003	0.0000001	-0.0000003	0.000002	-0.0000001
17	0.0	-0.000004	-0.0000002	-0.0000003	0.000002	-0.0000002
18	-0.0000009	0.000008	-0.0000003	-0.0000004	0.000004	0.0000002
19	0.0000008	0.000003	0.0000003	0.0000015	-0.000010	0.0000004
20	0.0000014	-0.000011	0.0000003	0.0000007	-0.000005	-0.0000003
21	-0.0000012	-0.000003	-0.0000002	-0.0000014	0.000008	-0.0000003
SUMS	38.1795749	-42.596105	4.4319781	24.8446775	-2.755944	11.2097814

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1980
SATURN AND URANUS

DAYS 1 THRU 95 JD 2444239.5 TO 2444334.5 DATES JAN 1 THRU APR 4

A = 47.50000000 B = -1.02105263

TERM	SATURN R A H	SATURN DEC DEG	SATURN DISTANCE AU	URANUS R A H	URANUS DEC DEG	URANUS DISTANCE AU
0	23.5115937	8.229227	17.3901946	31.0316476	-37.488010	37.3455443
1	-0.1586311	1.166811	-0.3273148	0.0338419	-0.116054	-0.7412192
2	-0.0336937	0.176734	0.1452910	-0.0330836	0.116968	0.0075887
3	0.0088205	-0.062991	0.0117148	-0.0003585	0.000188	0.0220189
4	0.0009625	-0.005319	-0.0025549	0.0005020	-0.001414	0.0000684
5	-0.0001309	0.001069	-0.0002006	0.0000214	-0.000051	-0.0001915
6	-0.0000236	0.000145	0.0000179	-0.0000017	0.0	-0.0000082
7	0.0000024	-0.000020	0.0000044	-0.0000002	0.000001	0.0000034
8	0.0000010	-0.000006	-0.0000139	0.0000022	-0.000005	-0.0000046
9	-0.0000066	0.000031	-0.0000039	0.0000002	-0.000004	-0.0000182
10	-0.0000016	0.000008	0.0000170	-0.0000035	0.000014	0.0000054
11	0.0000055	-0.000029	0.0000026	0.0000011	0.000003	0.0000118
12	0.0000012	-0.000006	-0.0000075	0.0000019	-0.000010	-0.0000023
13	-0.0000015	0.000008	-0.0000009	0.0	0.0	-0.0000035
SUMS	23.3288978	9.505662	17.2171458	31.0325708	-37.488374	36.6337934

DAYS 92 THRU 186 JD 2444330.5 TO 2444425.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.93684211

TERM	SATURN R A H	SATURN DEC DEG	SATURN DISTANCE AU	URANUS R A H	URANUS DEC DEG	URANUS DISTANCE AU
0	23.0342732	11.259756	18.1763509	30.8141289	-36.701917	35.8015919
1	-0.0206035	-0.010497	0.6697809	-0.1196635	0.430649	0.0519279
2	0.0552174	-0.366537	0.0601599	0.0025930	-0.007704	0.1577865
3	0.0012970	-0.001823	-0.0196594	0.0050443	-0.018680	-0.0021234
4	-0.0010218	0.006013	-0.0001540	-0.0000989	0.000011	-0.0023774
5	0.0000736	-0.000572	0.0001844	-0.0000593	0.000231	0.0000378
6	0.0000033	0.000004	-0.0000131	0.0000005	0.000002	0.0000098
7	-0.0000025	0.000016	-0.0000024	0.0000005	-0.000002	-0.0000018
8	-0.0000052	0.000027	0.0000057	-0.0000022	0.0	-0.0000094
9	0.0000018	-0.000008	0.0000181	-0.0000038	0.000018	0.0000145
10	0.0000057	-0.000028	-0.0000066	0.0000021	-0.000005	0.0000112
11	-0.0000031	0.000016	-0.0000111	0.0000007	-0.000004	-0.0000096
12	-0.0000022	0.000010	0.0000030	-0.0000008	0.000006	-0.0000045
13	0.0000005	-0.000003	0.0000035	-0.0000007	0.000003	0.0000030
SUMS	23.0692342	10.886374	18.8866598	30.7019408	-36.297392	36.0068565

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1980
SATURN AND URANUS

DAYS 183 THRU 277 JD 2444421.5 TO 2444516.5 DATES JULY 1 THRU OCT 3

A = 47.50000000 B = -4.85263158

TERM	SATURN R A (H)	SATURN DEC (DEG)	SATURN DISTANCE (AU)	URANUS R A (H)	URANUS DEC (DEG)	URANUS DISTANCE (AU)
0	23.6415692	6.899969	20.4507016	30.6343897	-36.094330	37.5697455
1	0.3115565	-2.073800	0.3842483	0.0476022	-0.197721	0.7429020
2	0.0223440	-0.121832	-0.1144025	0.0310324	-0.116494	-0.0073517
3	-0.0046097	0.031161	-0.0080315	-0.0006734	0.003825	-0.0199436
4	-0.0000406	0.000361	0.0011210	-0.0003681	0.001679	0.0002611
5	-0.0000001	0.000001	0.0000290	0.0000165	-0.000089	0.0001304
6	0.0000015	-0.000013	0.0000090	0.0000009	-0.000006	0.0000073
7	-0.0000006	0.000003	0.0000025	-0.0000007	0.000001	-0.0000002
8	0.0000044	-0.000023	0.0000108	0.0000001	0.000005	0.0000150
9	0.0000044	-0.000023	-0.0000141	0.0000034	-0.000016	0.0000031
10	-0.0000039	0.000017	-0.0000118	0.0000011	-0.000009	-0.0000168
11	-0.0000021	0.000012	0.0000081	-0.0000019	0.0	-0.0000022
12	0.0000006	-0.000002	0.0000047	-0.0000014	0.000006	0.0000070
13	0.0000007	-0.000004	-0.0000027	0.0000007	-0.000003	0.0000005
SUMS	23.9708243	4.735827	20.7136724	30.7120015	-36.403152	38.2857574

DAYS 275 THRU 369 JD 2444513.5 TO 2444608.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.78947368

TERM	SATURN R A (H)	SATURN DEC (DEG)	SATURN DISTANCE (AU)	URANUS R A (H)	URANUS DEC (DEG)	URANUS DISTANCE (AU)
0	24.8468048	-0.701260	20.0906069	31.1419407	-37.960748	39.2350056
1	0.2660950	-1.556049	-0.5538566	0.1904794	-0.663966	0.0038347
2	-0.0351099	0.256223	-0.0926041	0.0006174	0.011572	-0.1503871
3	-0.0050706	0.030531	0.0128014	-0.0038077	0.013187	-0.0005941
4	0.0000976	-0.001266	0.0014735	-0.0000482	-0.000338	0.0019363
5	0.0000463	-0.000310	-0.0000208	0.0000186	-0.000070	0.0000422
6	0.0000063	-0.000034	-0.0000203	0.0000025	0.000003	-0.0000134
7	0.0000014	-0.000008	-0.0000004	0.0000004	0.0	0.0000018
8	0.0000003	-0.000003	-0.0000149	0.0000020	-0.000003	-0.0000071
9	-0.0000053	0.000028	-0.0000038	-0.0000003	-0.000002	-0.0000166
10	-0.0000011	0.000009	0.0000167	-0.0000026	0.000013	0.0000081
11	0.0000047	-0.000025	0.0000027	0.0000018	-0.000002	0.0000109
12	0.0000007	-0.000006	-0.0000069	0.0000013	-0.000009	-0.0000034
13	-0.0000010	0.000005	-0.0000007	0.0	-0.000001	-0.0000031
SUMS	25.0728692	-1.972165	19.4583727	31.3292053	-38.600364	39.0898148

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1980
NEPTUNE AND PLUTO

DAYS 1 THRU 95 JD 2444239.5 TO 2444334.5 DATES JAN 1 THRU APR 4

A = 47.50000000 B = -1.02105263

TERM	NEPTUNE R A H	NEPTUNE DEC DEG	NEPTUNE DISTANCE AU	PLUTO R A † H	PLUTO DEC † DEG	PLUTO DISTANCE AU
0	34.8571314	-43.680212	61.2147114	27.4458971	16.005800	59.3825988
1	0.0630094	-0.028077	-0.6847495	-0.0246749	0.527751	-0.5953653
2	-0.0190004	0.020279	-0.0646786	-0.0172406	0.047474	0.0918755
3	-0.0013569	-0.000532	0.0198461	0.0012661	-0.020159	0.0177034
4	0.0002525	-0.000194	0.0009616	0.0002953	-0.000972	-0.0014307
5	0.0000137	0.000023	-0.0001582	-0.0000087	0.000212	-0.0001758
6	-0.0000004	0.000004	-0.0000047	-0.0000020	0.000013	0.0000022
7	-0.0000002	0.000001	0.0000032	0.0000002	-0.000004	0.0000027
8	0.0000012	0.000004	0.0000020	0.0000012	-0.000001	-0.0000109
9	0.0000020	-0.000002	-0.0000192	-0.0000018	0.000014	-0.0000116
10	-0.0000023	0.000004	-0.0000024	-0.0000014	0.000001	0.0000133
11	0.0000001	0.000006	0.0000122	0.0000011	-0.000009	0.0000077
SUMS	34.9000501	-43.688696	60.4859239	27.4055316	16.560120	58.8951893

DAYS 92 THRU 186 JD 2444330.5 TO 2444425.5 DATES APR 1 THRU JULY 4

A = 47.50000000 B = -2.93684211

TERM	NEPTUNE R A H	NEPTUNE DEC DEG	NEPTUNE DISTANCE AU	PLUTO R A † H	PLUTO DEC † DEG	PLUTO DISTANCE AU
0	34.8239670	-43.571229	58.9973108	27.2459196	17.432864	58.9952347
1	-0.0728711	0.071794	-0.3120575	-0.0584492	0.073561	0.4128304
2	-0.0092948	0.002885	0.1429652	0.0100555	-0.137167	0.1178836
3	0.0028038	-0.002406	0.0087633	0.0022226	-0.003869	-0.0132094
4	0.0001470	-0.000133	-0.0020709	-0.0001927	0.002188	-0.0015055
5	-0.0000258	0.0	-0.0000744	-0.0000170	-0.000025	0.0001292
6	-0.0000016	-0.000005	0.0000016	0.0000009	-0.000009	0.0000027
7	0.0	0.0	-0.0000003	0.0000001	0.000002	-0.0000028
8	-0.0000004	-0.000007	-0.0000137	-0.0000018	0.000010	-0.0000019
9	-0.0000036	0.000005	0.0000067	-0.0000005	-0.000007	0.0000185
10	-0.0000001	0.000001	0.0000161	0.0000021	-0.000012	0.0000021
11	0.0000035	0.000001	-0.0000046	0.0000003	0.000005	-0.0000120
SUMS	34.7447209	-43.499094	58.8348423	27.1995399	17.367541	59.5113696

† ASTROMETRIC POSITION, EQUATOR AND EQUINOX 1950.0

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1980
NEPTUNE AND PLUTO

DAYS 183 THRU 277 JD 2444421.5 TO 2444516.5 DATES JULY 1 THRU OCT 3

A = 47.50000000 B = -4.85263158

	NEPTUNE R A	NEPTUNE DEC	NEPTUNE DISTANCE	PLUTO R A †	PLUTO DEC †	PLUTO DISTANCE
TERM	H	DEG	AU	H	DEG	AU
0	34.5980074	-43.422422	59.7990478	27.2439681	16.029177	61.1600479
1	-0.0228926	-0.013780	0.6709387	0.0614276	-0.729897	0.5630712
2	0.0193513	-0.022128	0.0660994	0.0154193	-0.039287	-0.0820724
3	0.0011007	-0.000460	-0.0190704	-0.0011926	0.016118	-0.0154761
4	-0.0002632	0.000425	-0.0008576	-0.0001706	0.000312	0.0010240
5	-0.0000054	0.000016	0.0001433	0.0000077	-0.000082	0.0001026
6	0.0000018	-0.000002	0.0000124	0.0000005	-0.000004	0.0000079
7	-0.0000003	-0.000003	-0.0000015	-0.0000003	0.000001	0.0000008
8	-0.0000008	0.000004	0.0000118	0.0000005	-0.000009	0.0000137
9	0.0000015	-0.000007	0.0000120	0.0000022	-0.000009	-0.0000071
10	0.0000020	-0.000004	-0.0000136	-0.0000007	0.000010	-0.0000157
11	-0.0000006	-0.000007	-0.0000074	-0.0000013	0.000005	0.0000042
SUMS	34.5952818	-43.458368	60.5163149	27.3194604	15.276335	61.6267010

DAYS 275 THRU 369 JD 2444513.5 TO 2444608.5 DATES OCT 1 THRU JAN 3

A = 47.50000000 B = -6.78947368

	NEPTUNE R A	NEPTUNE DEC	NEPTUNE DISTANCE	PLUTO R A †	PLUTO DEC †	PLUTO DISTANCE
TERM	H	DEG	AU	H	DEG	AU
0	34.7834642	-43.711545	62.0401324	27.5887690	13.692601	61.5238623
1	0.1103422	-0.115743	0.3231833	0.0983855	-0.347503	-0.4095535
2	0.0089369	0.002308	-0.1394339	-0.0077052	0.124210	-0.1247838
3	-0.0024639	0.003179	-0.0094839	-0.0022432	0.007756	0.0103382
4	-0.0001150	-0.000131	0.0018988	0.0000614	-0.001475	0.0018703
5	0.0000156	-0.000039	0.0001038	0.0000195	-0.000115	-0.0000440
6	0.0000016	0.000008	-0.0000098	0.0000013	0.000002	-0.0000228
7	0.0	0.000001	0.0000020	0.0000003	-0.000001	0.0000006
8	0.0000012	0.000005	-0.0000009	0.0000009	0.0	-0.0000127
9	0.0000015	-0.000002	-0.0000192	-0.0000019	0.000014	-0.0000088
10	-0.0000019	0.000004	0.0000008	-0.0000011	0.0	0.0000146
11	0.0000007	0.000003	0.0000121	0.0000012	-0.000010	0.0000060
SUMS	34.9001831	-43.821952	62.2163855	27.6772877	13.475479	61.0016664

† ASTROMETRIC POSITION, EQUATOR AND EQUINOX 1950.0

CHEBYSHEV APPROXIMATION OF SIDEREAL TIME FOR YEAR 1980

DAYS 1 THRU 366 JD 2444239.5 TO 2444605.5 DATES JAN 1 THRU DEC 31

A = 183.00000000 B = -1.00546448

TERM	APP S T	EQ OF EQ	NUT LON	NUT OBL
	H	S	"	"
0	37.35790861	-1.2952	-21.1753	-14.7326
1	12.02484819	-0.1782	-2.9141	0.9004
2	0.00000514	0.0185	0.3024	-0.2564
3	0.00000098	0.0035	0.0578	-0.0412
4	0.00000552	0.0199	0.3249	-0.3369
5	0.00001376	0.0495	0.8099	0.2100
6	-0.00000451	-0.0162	-0.2652	0.2816
7	-0.00000635	-0.0229	-0.3739	-0.0289
8	0.00000206	0.0074	0.1212	-0.0500
9	0.00000058	0.0021	0.0341	0.0254
SUMS	49.38277398	-1.4116	-23.0782	-14.0286

CHEBYSHEV APPROXIMATION OF SOLAR COORDINATES FOR YEAR 1980

DAYS 1 THRU 366 JD 2444239.5 TO 2444605.5 DATES JAN 1 THRU DEC 31

A = 183.00000000 B = -1.00546448

TERM	R A	DEC	DISTANCE	S D	EPHEM TR
	H	DEG	AU	'	H
0	61.3798984	-13.485026	1.98998373	32.20530	24.0239100
1	11.8882784	-2.371409	0.00040082	-0.00651	-0.1361512
2	0.0274567	-22.511744	-0.01629251	0.26234	0.0301137
3	0.0728274	2.734964	-0.00045237	0.00724	0.0729307
4	0.0399380	6.654348	0.00500746	-0.07879	0.0414091
5	0.1047579	-0.370476	0.00006182	-0.00085	0.1039803
6	-0.0307469	-0.499175	-0.00042170	0.00552	-0.0321237
7	-0.0441609	0.064997	0.00000621	-0.00016	-0.0438798
8	0.0071710	0.073062	0.00000367	0.00024	0.0074620
9	0.0074422	-0.038612	0.00000513	-0.00008	0.0073738
10	-0.0020151	-0.036087	0.00000209	-0.00006	-0.0020889
11	-0.0017746	0.012058	0.00000568	-0.00009	-0.0017310
12	0.0010209	0.008821	0.00000356	-0.00006	0.0010632
13	0.0006818	-0.003071	0.00000282	-0.00005	0.0006652
14	-0.0003326	-0.001719	0.00000528	-0.00009	-0.0003432
15	-0.0001905	0.001055	-0.00000141	0.00002	-0.0001850
16	0.0001304	0.000510	0.00000392	-0.00006	0.0001366
17	0.0000686	-0.000433	-0.00000569	0.00009	0.0000634
18	-0.0000403	-0.000207	0.00000007	0.0	-0.0000417
19	0.0000069	0.000130	-0.00000566	0.00009	0.0000048
20	-0.0000085	-0.000014	-0.00000470	0.00008	-0.0000094
21	0.0000025	0.000032	0.0	0.0	0.0000021
SUMS	73.4504117	-29.767996	1.97830822	32.39412	24.0725610

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1980
MERCURY AND VENUS

DAYS 1 THRU 366 JD 2444239.5 TO 2444605.5 DATES JAN 1 THRU DEC 31

A = 183.00000000 B = -1.00546448

TERM	MERCURY R A (H)	MERCURY DEC (DEG)	MERCURY DISTANCE (AU)	VENUS R A (H)	VENUS DEC (DEG)	VENUS DISTANCE (AU)
0	61.1590076	-16.259388	2.2847451	61.3299771	3.886667	2.0389198
1	11.9348903	-2.057468	0.0138161	8.9954521	-4.091478	0.1263595
2	-0.2888502	-21.060221	0.2479819	0.5199066	-23.697362	0.5067310
3	-0.0962828	2.832695	-0.0263792	1.4227831	2.942652	-0.0623428
4	0.0098143	6.142098	0.1198710	-0.3064634	-1.087741	-0.1241152
5	0.6096034	-0.138879	0.0382059	-0.5823235	-0.456128	0.0288473
6	-0.1073015	-4.470863	0.0046127	0.2491301	3.250235	0.0372145
7	0.5496339	-1.590931	0.0425877	0.3340216	0.307474	-0.0159313
8	0.2654045	2.672040	-0.2308540	-0.1866950	-1.320107	-0.0135762
9	-0.8443272	-0.342205	-0.0648524	-0.1589771	-0.234689	0.0091161
10	-0.1787411	2.868818	0.1552987	0.1258262	0.568902	0.0053996
11	0.3264153	1.741017	0.0271610	0.0647372	0.169417	-0.0053237
12	0.0366467	-3.501402	-0.0202559	-0.0830444	-0.287433	-0.0021362
13	-0.0036084	-0.774155	0.0004251	-0.0231529	-0.119475	0.0031704
14	-0.0149232	0.942527	-0.0012675	0.0539379	0.172299	0.0007660
15	0.0970612	-0.336210	0.0034000	0.0052171	0.076011	-0.0019054
16	0.0735285	0.053991	-0.0252246	-0.0344902	-0.118477	-0.0001739
17	-0.1812294	0.155360	-0.0113232	0.0021192	-0.043393	0.0011320
18	-0.0843557	0.552784	0.0152501	0.0217306	0.085470	-0.0000588
19	0.0705558	0.403835	0.0066619	-0.0046186	0.021436	-0.0006782
20	0.0325514	-0.628283	0.0111909	-0.0134260	-0.061908	0.0001233
21	0.0423270	-0.314780	0.0009469	0.0050258	-0.007617	0.0003983
22	0.0021333	-0.006256	-0.0147374	0.0080131	0.044169	-0.0001387
23	-0.0315672	-0.097653	-0.0013522	-0.0045534	-0.000119	-0.0002196
24	0.0109002	0.294234	0.0036468	-0.0045810	-0.030644	0.0001230
25	-0.0138464	0.156469	-0.0019786	0.0037148	0.003923	0.0001249
26	-0.0271697	-0.085244	0.0001683	0.0024932	0.020833	-0.0000880
27	0.0082170	0.064822	0.0023447	-0.0028483	-0.005576	-0.0000729
28	0.0157720	-0.048719	0.0027299	-0.0012219	-0.013970	0.0000646
29	0.0167985	-0.128854	-0.0001032	0.0021197	0.005914	0.0000326
30	0.0021263	-0.043188	-0.0025214	0.0004599	0.009053	-0.0000536
31	-0.0139513	-0.004782	-0.0008419	-0.0015255	-0.005407	-0.0000066
32	-0.0023279	0.090552	-0.0007373	-0.0000554	-0.005507	0.0000411
33	-0.0034039	0.072844	-0.0000843	0.0010371	0.004496	-0.0000007
34	-0.0063774	-0.011799	0.0019435	-0.0001084	0.003112	-0.0000248
35	0.0066281	-0.003810	0.0006568	-0.0006562	-0.003560	-0.0000020
36	0.0064063	-0.042260	-0.0008149	0.0001412	-0.001650	0.0000109
37	0.0008087	-0.048857	-0.0001013	0.0003888	0.002740	0.0000049
38	0.0003110	0.016440	0.0001124	-0.0001277	0.000809	-0.0000038
39	-0.0026660	0.013011	-0.0003807	-0.0002205	-0.002030	-0.0000051
40	-0.0023461	0.007402	-0.0003867	0.0001030	-0.000322	0.0000013
41	-0.0012548	0.027016	0.0001227	0.0001206	0.001454	0.0000036
42	-0.0010702	0.007254	0.0004236	-0.0000792	0.000050	-0.0000004
43	0.0022778	-0.011508	0.0002330	-0.0000637	-0.001005	-0.0000021
44	0.0026839	-0.017681	0.0000334	0.0000612	0.000092	0.0000006
45	0.0003451	-0.016073	-0.0001558	0.0000327	0.000660	0.0000009
46	-0.0006110	0.003918	-0.0003059	-0.0000455	-0.000155	-0.0000007
47	-0.0016256	0.010786	-0.0000559	-0.0000150	-0.000422	-0.0000004
48	-0.0009299	0.007535	0.0001976	0.0000319	0.000168	0.0000003
49	0.0005504	0.007287	0.0000362	0.0000049	0.000270	0.0000001
SUMS	73.3746316	-32.896734	2.5800896	71.7392939	-20.017869	2.5317255

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1980
MARS AND JUPITER

DAYS 1 THRU 366 JD 2444239.5 TO 2444605.5 DATES JAN 1 THRU DEC 31

A = 183.00000000 B = -1.00546448

TERM	MARS R A	MARS DEC	MARS DISTANCE	JUPITER R A	JUPITER DEC	JUPITER DISTANCE
	H	DEG	AU	H	DEG	AU
0	27.5760557	-7.064796	2.9848849	22.4681798	12.151181	10.7567339
1	4.6280926	-20.583065	0.8351646	1.0421526	-6.606497	0.7252433
2	2.0923938	-4.577975	0.0629403	0.5913187	-3.641802	-0.4035608
3	-0.2368154	6.482392	-0.1897721	-0.1821501	1.153886	-0.5122120
4	-0.1250909	1.800034	0.0765457	-0.1031117	0.622222	0.1231300
5	0.1796563	-0.889939	-0.0032754	0.0489690	-0.238928	0.0370646
6	-0.1350057	0.490966	-0.0126375	-0.0137619	0.078745	-0.0169701
7	0.0145390	-0.278719	0.0094279	-0.0045810	0.004961	0.0065880
8	0.0326648	-0.051628	-0.0034218	0.0051162	-0.022584	0.0000432
9	-0.0286155	0.125559	-0.0003556	-0.0015566	0.011598	-0.0012165
10	0.0120543	-0.094044	0.0013718	-0.0001968	-0.001936	0.0005643
11	0.0020791	0.034671	-0.0009308	0.0004805	-0.001793	-0.0000700
12	-0.0063966	0.013216	0.0002554	-0.0002082	0.001504	-0.0000769
13	0.0042612	-0.026173	0.0001424	0.0000096	-0.000477	0.0000566
14	-0.0009746	0.017095	-0.0002014	0.0000467	-0.000118	-0.0000199
15	-0.0009589	-0.003585	0.0001183	-0.0000250	0.000167	-0.0000034
16	0.0012191	-0.004525	-0.0000145	0.0000050	-0.000084	-0.0000018
17	-0.0006015	0.005608	-0.0000304	0.0000010	0.000015	-0.0000040
18	0.0000165	-0.002908	0.0000297	-0.0000021	0.000015	-0.0000042
19	0.0002474	0.000082	-0.0000181	-0.0000044	0.000013	-0.0000029
20	-0.0002010	0.001195	-0.0000028	0.0000005	0.000004	0.0000022
21	0.0000640	-0.001091	-0.0000010	-0.0000029	0.000015	-0.0000018
22	0.0000197	0.000426	-0.0000037	-0.0000028	0.000016	0.0000077
23	-0.0000516	0.000092	-0.0000014	0.0000025	-0.000007	0.0000013
SUMS	34.0086518	-24.607112	3.7602145	23.8506786	3.510116	10.7152908

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1980
SATURN AND URANUS

DAYS 1 THRU 366 JD 2444239.5 TO 2444605.5 DATES JAN 1 THRU DEC 31

A = 183.00000000 B = -1.00546448

TERM	SATURN R A	SATURN DEC	SATURN DISTANCE	URANUS R A	URANUS DEC	URANUS DISTANCE
	H	DEG	AU	H	DEG	AU
0	23.9798408	5.010270	18.9012558	30.9929843	-37.378023	37.9196613
1	0.4220933	-2.771143	0.6926401	0.0667601	-0.258487	0.4557852
2	0.3568716	-2.270906	-0.2055264	0.1432652	-0.518170	0.6779223
3	-0.0527793	0.500078	-0.6119133	0.0951975	-0.327137	-0.4730836
4	-0.0923571	0.573656	0.0772683	-0.0465708	0.179421	-0.1995613
5	0.0202729	-0.143690	0.0740550	-0.0131747	0.052587	0.0774624
6	0.0026637	-0.007569	-0.0162061	0.0064260	-0.025131	0.0154424
7	-0.0045859	0.024929	0.0007589	0.0002614	-0.004675	-0.0068804
8	0.0015934	-0.011899	0.0021175	-0.0008059	0.003385	0.0001633
9	0.0003089	-0.000267	-0.0010916	0.0001422	0.000260	0.0006042
10	-0.0003588	0.002140	0.0000195	0.0000930	-0.000525	-0.0001622
11	0.0000985	-0.000918	0.0001489	-0.0000347	0.000042	-0.0000470
12	0.0000274	-0.000029	-0.0000634	-0.0000070	0.000077	0.0000265
13	-0.0000277	0.000183	0.0000032	0.0000059	-0.000018	0.0000082
14	0.0000068	-0.000078	0.0000038	0.0000004	-0.000009	-0.0000045
15	0.0000029	-0.000005	-0.0000038	-0.0000013	0.000002	0.0000010
SUMS	24.6336714	0.904752	18.9134664	31.2445416	-38.276401	38.4673378

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1980
NEPTUNE AND PLUTO

DAYS 1 THRU 366 JD 2444239.5 TO 2444605.5 DATES JAN 1 THRU DEC 31

A = 183.00000000 B = -1.00546448

TERM	NEPTUNE R A	NEPTUNE DEC	NEPTUNE DISTANCE	PLUTO R A †	PLUTO DEC †	PLUTO DISTANCE
	H	DEG	AU	H	DEG	AU
0	34.7900039	-43.644709	61.0961104	27.4498229	15.297944	60.3841983
1	0.0035924	-0.030490	0.1835514	0.0538401	-0.671359	0.4980096
2	0.0413287	-0.078516	0.9202272	0.1105957	-0.784313	0.1787172
3	0.0853380	-0.065148	-0.2135232	0.0237818	0.252242	-0.6206938
4	-0.0135417	0.025959	-0.2823804	-0.0340854	0.231880	-0.0474400
5	-0.0136639	0.012482	0.0349932	-0.0022080	-0.048070	0.0921501
6	0.0018124	-0.000983	0.0261338	0.0032643	-0.016142	0.0002009
7	0.0010513	-0.001859	-0.0029916	-0.0003849	0.006017	-0.0045986
8	-0.0002257	-0.000367	-0.0010911	-0.0001407	-0.000786	0.0009801
9	-0.0000712	0.000282	0.0002591	0.0001054	-0.000614	-0.0000915
10	0.0000301	0.000066	0.0000253	-0.0000050	0.000268	-0.0001435
11	0.0000047	-0.000043	-0.0000150	-0.0000104	0.000014	0.0000455
12	-0.0000042	-0.000004	-0.0000038	0.0000022	-0.000032	0.0000104
13	0.0000002	0.000009	-0.0000017	0.0000002	0.000009	-0.0000075
SUMS	34.8956550	-43.783321	61.7612936	27.6045782	14.267058	60.4813372

† ASTROMETRIC POSITION, EQUATOR AND EQUINOX 1950.0

Section E: STELLAR TABLES

INDEX OF STANDARD NAVIGATION STARS

	Nav. No.	A/C ID
Acamar	7	18
Achernar	5	11
Acrux	30	86
Adhara	19	50
Aldebaran	10	26
Alioth	32	94
Alkaid	34	101
Al Na'ir	55	170
Alnilam	15	37
Alphard	25	71
Alphecca	41	120
Alpheratz	1	1
Altair	51	160
Ankaa	2	5
Antares	42	128
Arcturus	37	106
Atria	43	133
Avior	22	64
Bellatrix	13	31
Betelgeuse	16	42
Canopus	17	46
Capella	12	30
Deneb	53	164
Denebola	28	82
Diphda	4	7
Dubhe	27	79
Elnath	14	32
Eltanin	47	147
Enif	54	168
Fomalhaut	56	173

	Nav. No.	A/C ID
Gacrux	31	88
Gienah	29	85
Hadar	35	104
Hamal	6	15
Kaus Australis	48	150
Kochab	40	114
Markab	57	175
Menkar	8	19
Menkent	36	105
Miaplacidus	24	68
Mirfak	9	21
Nunki	50	153
Peacock	52	162
Pollux	21	60
Procyon	20	59
Rasalhague	46	143
Regulus	26	74
Rigel	11	29
Rigil Kentaurus	38	109
Sabik	44	136
Schedar	3	6
Shaula	45	142
Sirius	18	48
Spica	33	99
Suhail	23	67
Vega	49	152
Zubenelgenubi	39	113

DAYS 1 THRU 366 JD 2444239.5 TO 2444605.5 DATES JAN 1 THRU DEC 31

A = 366.00000000 B = -0.00273224

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
1	1	ALPHA AND	2.1	SHA	358.1625	0.0008	-0.0114	0.0059	0.0008	358.1568
		ALPHERATZ	A0	DEC	28.9800	-0.0010	0.0050	-0.0023	0.0024	28.9791
2		BETA CAS	2.4	SHA	357.9746	-0.0016	-0.0111	0.0101	0.0013	357.9660
		CAPH	F5	DEC	59.0394	-0.0010	0.0050	-0.0018	0.0046	59.0363
3		GAMMA PEG	2.9	SHA	356.9492	0.0015	-0.0115	0.0054	0.0006	356.9443
		ALGENIB	B2	DEC	15.0725	-0.0010	0.0050	-0.0023	0.0011	15.0729
4		BETA HYI	2.9	SHA	353.8204	0.0117	-0.0109	0.0239	0.0013	353.8253
			G0	DEC	-77.3669	-0.0011	0.0050	-0.0001	-0.0056	-77.3600
5	2	ALPHA PHE	2.4	SHA	353.6758	0.0040	-0.0114	0.0071	0.0004	353.6738
		ANKAA	K0	DEC	-42.4147	-0.0011	0.0050	-0.0014	-0.0041	-42.4092
6	3	ALPHA CAS	2.3	SHA	350.1592	-0.0010	-0.0122	0.0095	-0.0001	350.1522
		SCHEDAR	K0	DEC	56.4278	-0.0013	0.0050	-0.0013	0.0045	56.4245
7	4	BETA CET	2.2	SHA	349.3538	0.0027	-0.0113	0.0055	-0.0002	349.3510
		DIPHDA	K0	DEC	-18.0961	-0.0013	0.0050	-0.0021	-0.0021	-18.0928
8		GAMMA CAS	2-3	SHA	346.1275	-0.0014	-0.0129	0.0107	-0.0010	346.1206
			B0	DEC	60.6089	-0.0014	0.0050	-0.0008	0.0047	60.6052
9		BETA AND	2.4	SHA	342.8483	0.0007	-0.0123	0.0064	-0.0010	342.8439
		MIRACH	M0	DEC	35.5147	-0.0015	0.0049	-0.0015	0.0030	35.5127
10		DELTA CAS	2.8	SHA	338.8763	-0.0010	-0.0140	0.0103	-0.0024	338.8706
		RUCHBAH	A5	DEC	60.1319	-0.0017	0.0048	-0.0003	0.0046	60.1281
11	5	ALPHA ERI	0.6	SHA	335.7575	0.0047	-0.0089	0.0094	-0.0028	335.7605
		ACHERNAR	B5	DEC	-57.3381	-0.0017	0.0047	-0.0022	-0.0048	-57.3326
12		BETA ARI	2.7	SHA	331.6171	0.0015	-0.0123	0.0053	-0.0020	331.6144
		SHERATAN	A5	DEC	20.7108	-0.0019	0.0046	-0.0015	0.0015	20.7097
13		ALPHA HYI	3.0	SHA	330.4650	0.0049	-0.0076	0.0104	-0.0042	330.4703
			F0	DEC	-61.6669	-0.0019	0.0046	-0.0025	-0.0049	-61.6617
14		GAMMA-1 AND	2.3	SHA	329.3338	0.0007	-0.0135	0.0066	-0.0028	329.3306
		ALMAK	K0	DEC	42.2344	-0.0019	0.0045	-0.0004	0.0033	42.2315
15	6	ALPHA ARI	2.2	SHA	328.4896	0.0014	-0.0125	0.0053	-0.0024	328.4872
		HAMAL	K2	DEC	23.3683	-0.0019	0.0045	-0.0013	0.0017	23.3669
16		BETA TRI	3.1	SHA	327.9129	0.0011	-0.0131	0.0059	-0.0027	327.9101
			A5	DEC	34.8933	-0.0020	0.0045	-0.0007	0.0027	34.8909
17		ALPHA UMI	2.1	SHA	327.0529	-0.0954	-0.1763	0.3361	-0.1597	327.0291
		POLARIS	F8	DEC	89.1736	-0.0020	0.0044	0.0020	0.0052	89.1687
18	7	THETA ERI	3.4	SHA	315.6246	0.0029	-0.0088	0.0057	-0.0043	315.6274
		ACAMAR	A2	DEC	-40.3842	-0.0022	0.0039	-0.0036	-0.0033	-40.3812
19	8	ALPHA CET	2.8	SHA	314.6921	0.0020	-0.0117	0.0043	-0.0034	314.6916
		MENKAR	M0	DEC	4.0119	-0.0022	0.0038	-0.0020	-0.0001	4.0117
20		BETA PER	2-3	SHA	313.2846	0.0013	-0.0144	0.0056	-0.0046	313.2833
		ALGOL	B8	DEC	40.8794	-0.0023	0.0037	0.0003	0.0026	40.8764

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
21	9	ALPHA PER	1.9	SHA	309.2783	0.0012	-0.0158	0.0062	-0.0059	309.2775
		MIRFAK	F5	DEC	49.7911	-0.0023	0.0035	0.0011	0.0030	49.7875
22		ETA TAU	3.0	SHA	303.4267	0.0019	-0.0133	0.0040	-0.0046	303.4265
		ALCYONE	B5	DEC	24.0442	-0.0024	0.0031	-0.0005	0.0012	24.0421
23		ZETA PER	2.9	SHA	301.7821	0.0018	-0.0140	0.0042	-0.0051	301.7819
			B1	DEC	31.8253	-0.0024	0.0030	0.0001	0.0016	31.8227
24		EPSILON PER	3.0	SHA	300.8733	0.0017	-0.0149	0.0045	-0.0057	300.8733
			B1	DEC	39.9533	-0.0024	0.0029	0.0008	0.0020	39.9503
25		GAMMA ERI	3.2	SHA	300.7263	0.0022	-0.0105	0.0036	-0.0045	300.7276
			K5	DEC	-13.5647	-0.0024	0.0029	-0.0031	-0.0012	-13.5644
26	10	ALPHA TAU	1.1	SHA	291.3071	0.0021	-0.0128	0.0029	-0.0051	291.3079
		ALDEBARAN	K5	DEC	16.4700	-0.0024	0.0022	-0.0009	0.0004	16.4682
27		IOTA AUR	2.9	SHA	286.0779	0.0022	-0.0146	0.0028	-0.0061	286.0790
			K2	DEC	33.1356	-0.0024	0.0018	0.0007	0.0010	33.1330
28		BETA ERI	2.9	SHA	283.2838	0.0020	-0.0111	0.0021	-0.0053	283.2855
			A3	DEC	-5.1114	-0.0024	0.0015	-0.0026	-0.0006	-5.1124
29	11	BETA ORI	0.3	SHA	281.6058	0.0020	-0.0108	0.0020	-0.0054	281.6078
		RIGEL	B8	DEC	-8.2239	-0.0024	0.0014	-0.0029	-0.0007	-8.2249
30	12	ALPHA AUR	0.2	SHA	281.1975	0.0025	-0.0165	0.0028	-0.0077	281.1995
		CAPELLA	G0	DEC	45.9792	-0.0024	0.0014	0.0019	0.0011	45.9763
31	13	GAMMA ORI	1.7	SHA	278.9858	0.0021	-0.0120	0.0018	-0.0054	278.9874
		BELLATRIX	B2	DEC	6.3325	-0.0024	0.0012	-0.0017	-0.0002	6.3309
32	14	BETA TAU	1.8	SHA	278.7433	0.0024	-0.0142	0.0020	-0.0062	278.7448
		ELNATH	B8	DEC	28.5917	-0.0024	0.0012	0.0004	0.0005	28.5894
33		BETA LEP	3.0	SHA	278.1529	0.0019	-0.0096	0.0018	-0.0058	278.1558
			G0	DEC	-20.7747	-0.0024	0.0011	-0.0038	-0.0010	-20.7756
34		DELTA ORI	2.5	SHA	277.2542	0.0021	-0.0115	0.0016	-0.0055	277.2560
			B0	DEC	-0.3131	-0.0024	0.0010	-0.0023	-0.0004	-0.3145
35		ALPHA LEP	2.7	SHA	277.0383	0.0019	-0.0099	0.0017	-0.0057	277.0410
			F0	DEC	-17.8356	-0.0023	0.0010	-0.0037	-0.0008	-17.8365
36		IOTA ORI	2.9	SHA	276.3867	0.0020	-0.0110	0.0015	-0.0055	276.3887
			O5	DEC	-5.9219	-0.0023	0.0010	-0.0027	-0.0005	-5.9233
37	15	EPSILON ORI	1.7	SHA	276.2004	0.0021	-0.0114	0.0015	-0.0055	276.2023
		ALNILAM	B0	DEC	-1.2136	-0.0023	0.0009	-0.0023	-0.0004	-1.2151
38		ZETA TAU	3.0	SHA	275.8879	0.0023	-0.0134	0.0016	-0.0059	275.8894
			B3	DEC	21.1314	-0.0023	0.0009	-0.0003	0.0002	21.1293
39		ALPHA COL	2.7	SHA	275.2692	0.0016	-0.0082	0.0017	-0.0066	275.2733
		PHACT	B5	DEC	-34.0842	-0.0023	0.0009	-0.0047	-0.0011	-34.0850
40		ZETA ORI	2.0	SHA	275.0629	0.0020	-0.0113	0.0014	-0.0055	275.0648
		ALNITAK	B0	DEC	-1.9522	-0.0023	0.0008	-0.0024	-0.0004	-1.9537
41		KAPPA ORI	2.2	SHA	273.2983	0.0019	-0.0107	0.0013	-0.0056	273.3006
			B0	DEC	-9.6758	-0.0023	0.0007	-0.0031	-0.0006	-9.6772
42	16	ALPHA ORI	0-1	SHA	271.4779	0.0022	-0.0121	0.0011	-0.0056	271.4797
		BETELGEUSE	M0	DEC	7.4044	-0.0023	0.0005	-0.0016	-0.0002	7.4027
43		BETA AUR	2.1	SHA	270.4846	0.0029	-0.0165	0.0014	-0.0079	270.4872
		MENKALINAN	A0	DEC	44.9469	-0.0023	0.0004	0.0021	0.0004	44.9445

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					°	°	°	°	°	°
44		THETA AUR	2.7	SHA	270.4108	0.0027	-0.0153	0.0013	-0.0070	270.4130
			A0	DEC	37.2125	-0.0023	0.0004	0.0013	0.0003	37.2102
45		BETA CMA	2.0	SHA	264.5454	0.0017	-0.0099	0.0005	-0.0060	264.5482
		MIRZAM	B1	DEC	-17.9453	-0.0022	-0.0001	-0.0037	-0.0005	-17.9470
46	17	ALPHA CAR	-0.9	SHA	264.1229	0.0006	-0.0049	0.0007	-0.0094	264.1304
		CANOPUS	F0	DEC	-52.6844	-0.0022	-0.0001	-0.0055	-0.0005	-52.6862
47		GAMMA GEM	1.9	SHA	260.8608	0.0024	-0.0130	0.0001	-0.0059	260.8627
		ALHENA	A0	DEC	16.4175	-0.0021	-0.0004	-0.0007	-0.0004	16.4156
48	18	ALPHA CMA A	-1.6	SHA	258.9342	0.0017	-0.0100	-0.0000	-0.0059	258.9368
		SIRIUS	A0	DEC	-16.6883	-0.0020	-0.0006	-0.0036	-0.0003	-16.6903
49		TAU PUP	2.8	SHA	257.6404	0.0004	-0.0054	-0.0002	-0.0089	257.6470
			K0	DEC	-50.5906	-0.0020	-0.0007	-0.0055	0.0000	-50.5929
50	19	EPSILON CMA	1.6	SHA	255.5400	0.0013	-0.0088	-0.0004	-0.0065	255.5434
		ADHARA	B1	DEC	-28.9442	-0.0020	-0.0009	-0.0045	-0.0001	-28.9465
51		OMICRON-2 CMA	3.1	SHA	254.4525	0.0014	-0.0093	-0.0005	-0.0062	254.4554
			B5	DEC	-23.8033	-0.0019	-0.0009	-0.0041	-0.0001	-23.8056
52		DELTA CMA	2.0	SHA	253.1C54	0.0013	-0.0091	-0.0006	-0.0063	253.1085
		WEZEN	F8	DEC	-26.3606	-0.0019	-0.0011	-0.0043	-0.0000	-26.3630
53		PI PUP	2.7	SHA	250.8908	0.0009	-0.0078	-0.0010	-0.0070	250.8948
			K5	DEC	-37.0608	-0.0018	-0.0013	-0.0049	0.0003	-37.0636
54		ETA CMA	2.4	SHA	249.1742	0.0012	-0.0088	-0.0011	-0.0064	249.1773
			B5	DEC	-29.2633	-0.0018	-0.0014	-0.0045	0.0002	-29.2661
55		BETA CMI	3.1	SHA	248.4833	0.0023	-0.0122	-0.0010	-0.0056	248.4852
			B8	DEC	8.3306	-0.0018	-0.0015	-0.0015	-0.0006	8.3286
56		SIGMA PUP	3.3	SHA	247.8513	0.0005	-0.0070	-0.0014	-0.0076	247.8558
			K5	DEC	-43.2606	-0.0018	-0.0015	-0.0051	0.0006	-43.2637
57		ALPHA GEM A	2.0	SHA	246.6692	0.0031	-0.0145	-0.0014	-0.0065	246.6716
		CASTOR	A0	DEC	31.9333	-0.0017	-0.0016	0.0008	-0.0011	31.9319
58		ALPHA GEM B	2.8	SHA	246.6683	0.0031	-0.0145	-0.0014	-0.0065	246.6707
			A0	DEC	31.9333	-0.0017	-0.0016	0.0008	-0.0011	31.9319
59	20	ALPHA CMI A	0.5	SHA	245.4363	0.0022	-0.0119	-0.0013	-0.0055	245.4380
		PROCYON	F5	DEC	5.2769	-0.0017	-0.0017	-0.0018	-0.0005	5.2749
60	21	BETA GEM	1.2	SHA	243.9767	0.0030	-0.0140	-0.0016	-0.0062	243.9789
		POLLUX	K0	DEC	28.0756	-0.0016	-0.0018	0.0004	-0.0011	28.0741
61		ZETA PUP	2.3	SHA	239.2800	0.0005	-0.0077	-0.0023	-0.0069	239.2835
			O	DEC	-39.9461	-0.0015	-0.0022	-0.0049	0.0011	-39.9497
62		RHO PUP	2.9	SHA	238.3271	0.0012	-0.0095	-0.0021	-0.0057	238.3293
			F5	DEC	-24.2458	-0.0014	-0.0023	-0.0040	0.0005	-24.2490
63		GAMMA-2 VEL	1.9	SHA	237.7713	-0.0001	-0.0067	-0.0028	-0.0077	237.7755
			O	DEC	-47.2772	-0.0014	-0.0023	-0.0051	0.0014	-47.2812
64	22	EPSILON CAR	1.7	SHA	234.4738	-0.0014	-0.0042	-0.0043	-0.0100	234.4803
		AVIOR	*	DEC	-59.4450	-0.0013	-0.0026	-0.0052	0.0020	-59.4496
65		DELTA VEL	2.0	SHA	228.9621	-0.0010	-0.0058	-0.0046	-0.0083	228.9665
			A0	DEC	-54.6347	-0.0011	-0.0030	-0.0050	0.0022	-54.6396
66		IOTA UMA	3.1	SHA	225.5392	0.0045	-0.0158	-0.0044	-0.0069	225.5427
			A5	DEC	48.1208	-0.0010	-0.0032	0.0018	-0.0027	48.1210

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
67	23	LAMBDA VEL	2.2	SHA	223.1850	-0.0001	-0.0080	-0.0042	-0.0062	223.1871
		SUHAIL	K5	DEC	-43.3514	-0.0009	-0.0034	-0.0045	0.0021	-43.3561
68	24	BETA CAR	1.8	SHA	221.7529	-0.0041	-0.0017	-0.0092	-0.0126	221.7606
		MIAPLACIDUS	A0	DEC	-69.6347	-0.0008	-0.0035	-0.0047	0.0032	-69.6405
69		IOTA CAR	2.2	SHA	220.8613	-0.0018	-0.0055	-0.0064	-0.0085	220.8652
			F0	DEC	-59.1911	-0.0008	-0.0035	-0.0047	0.0029	-59.1966
70		KAPPA VEL	2.6	SHA	219.6267	-0.0012	-0.0065	-0.0058	-0.0074	219.6296
			B3	DEC	-54.9250	-0.0007	-0.0036	-0.0046	0.0028	-54.9304
71	25	ALPHA HYA	2.2	SHA	218.3488	0.0017	-0.0110	-0.0035	-0.0042	218.3492
		ALPHARD	K2	DEC	-8.5714	-0.0007	-0.0037	-0.0028	0.0002	-8.5741
72		N VEL	3.0	SHA	217.3467	-0.0015	-0.0063	-0.0064	-0.0075	217.3495
			K5	DEC	-56.9458	-0.0007	-0.0037	-0.0045	0.0031	-56.9514
73		EPSILON LEO	3.1	SHA	213.8204	0.0031	-0.0129	-0.0041	-0.0042	213.8213
			G0	DEC	23.8669	-0.0005	-0.0039	-0.0006	-0.0020	23.8665
74	26	ALPHA LEO	1.3	SHA	208.1729	0.0026	-0.0121	-0.0042	-0.0035	208.1730
		REGULUS	B8	DEC	12.0653	-0.0003	-0.0042	-0.0015	-0.0013	12.0642
75		GAMMA-1 LEO	2.6	SHA	205.2821	0.0030	-0.0124	-0.0045	-0.0034	205.2822
		ALGEIBA	K0	DEC	19.9431	-0.0002	-0.0043	-0.0010	-0.0020	19.9427
76		THETA CAR	3.0	SHA	199.4400	-0.0030	-0.0072	-0.0104	-0.0062	199.4396
			B0	DEC	-64.2894	0.0001	-0.0046	-0.0033	0.0043	-64.2960
77		MU VEL	2.8	SHA	198.5238	-0.0008	-0.0092	-0.0070	-0.0040	198.5224
			G5	DEC	-49.3142	0.0001	-0.0046	-0.0034	0.0036	-49.3199
78		BETA UMA	2.4	SHA	194.8392	0.0057	-0.0140	-0.0086	-0.0042	194.8420
		MERAK	A0	DEC	56.4897	0.0003	-0.0047	0.0006	-0.0045	56.4922
79	27	ALPHA UMA	1.9	SHA	194.3742	0.0066	-0.0146	-0.0101	-0.0048	194.3782
		DUBHE	K0	DEC	61.8592	0.0003	-0.0047	0.0009	-0.0048	61.8619
80		PSI UMA	3.1	SHA	192.8642	0.0044	-0.0130	-0.0067	-0.0030	192.8651
			K0	DEC	44.6072	0.0004	-0.0048	-0.0001	-0.0040	44.6092
81		DELTA LEO	2.6	SHA	191.7383	0.0030	-0.0120	-0.0052	-0.0022	191.7374
			A3	DEC	20.6333	0.0004	-0.0048	-0.0014	-0.0022	20.6336
82	28	BETA LEO	2.2	SHA	182.9900	0.0027	-0.0117	-0.0053	-0.0012	182.9881
		DENEBOLA	A2	DEC	14.6839	0.0008	-0.0050	-0.0018	-0.0018	14.6840
83		GAMMA UMA	2.5	SHA	181.8042	0.0052	-0.0123	-0.0087	-0.0018	181.8050
		PHECDA	A0	DEC	53.8058	0.0008	-0.0050	-0.0004	-0.0047	53.8089
84		DELTA CEN	2.9	SHA	178.1713	-0.0006	-0.0112	-0.0082	-0.0011	178.1661
			B3	DEC	-50.6111	0.0010	-0.0050	-0.0020	0.0041	-50.6168
85	29	GAMMA CRV	2.8	SHA	176.3063	0.0014	-0.0115	-0.0054	-0.0006	176.3024
		GIENAH	B8	DEC	-17.4311	0.0010	-0.0050	-0.0023	0.0013	-17.4339
86	30	ALPHA CRU A	1.6	SHA	173.6308	-0.0021	-0.0118	-0.0115	-0.0006	173.6234
		ACRUX	B1	DEC	-62.9883	0.0011	-0.0050	-0.0014	0.0049	-62.9946
87		ALPHA CRU B	2.1	SHA	173.6288	-0.0021	-0.0118	-0.0115	-0.0006	173.6213
			B3	DEC	-62.9886	0.0011	-0.0050	-0.0014	0.0049	-62.9949
88	31	GAMMA CRU	1.6	SHA	172.4879	-0.0012	-0.0119	-0.0096	-0.0003	172.4811
		GACRUX	M3	DEC	-57.0014	0.0012	-0.0050	-0.0015	0.0046	-57.0073
89		BETA CRV	2.8	SHA	171.6667	0.0012	-0.0116	-0.0057	-0.0001	171.6621
			G5	DEC	-23.2864	0.0012	-0.0050	-0.0021	0.0019	-23.2896

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
90		ALPHA MUS	2.9	SHA	171.0054	-0.0034	-0.0125	-0.0146	-0.0000	170.9958
			B3	DEC	-69.0256	0.0012	-0.0050	-0.0009	0.0052	-69.0320
91		GAMMA CEN	2.4	SHA	169.8983	-0.0003	-0.0120	-0.0080	0.0002	169.8919
		MUHLIFAIN	A0	DEC	-48.8500	0.0013	-0.0050	-0.0015	0.0040	-48.8552
92		GAMMA VIR	2.9	SHA	169.8388	0.0020	-0.0115	-0.0052	0.0001	169.8349
			F0	DEC	-1.3400	0.0013	-0.0050	-0.0022	-0.0003	-1.3410
93		BETA CRU	1.5	SHA	168.3642	-0.0014	-0.0125	-0.0103	0.0005	168.3560
		MIMOSA	B1	DEC	-59.5797	0.0013	-0.0050	-0.0011	0.0047	-59.5856
94	32	EPSILON UMA	1.7	SHA	166.7117	0.0050	-0.0104	-0.0094	0.0008	166.7107
		ALIOTH	A0	DEC	56.0681	0.0014	-0.0050	-0.0014	-0.0049	56.0719
95		ALPHA-2 CVN	2.9	SHA	166.2267	0.0036	-0.0109	-0.0067	0.0006	166.2243
		COR CAROLI	A0	DEC	38.4261	0.0014	-0.0050	-0.0019	-0.0038	38.4289
96		EPSILON VIR	2.9	SHA	164.7050	0.0024	-0.0113	-0.0053	0.0006	164.7012
			K0	DEC	11.0664	0.0015	-0.0049	-0.0023	-0.0015	11.0668
97		IOTA CEN	2.9	SHA	160.1329	0.0007	-0.0125	-0.0064	0.0013	160.1261
			A2	DEC	-36.6072	0.0016	-0.0048	-0.0013	0.0030	-36.6110
98		ZETA UMA	2.4	SHA	159.2196	0.0046	-0.0095	-0.0090	0.0020	159.2174
		MIZAR	A2	DEC	55.0294	0.0016	-0.0048	-0.0020	-0.0048	55.0335
99	33	ALPHA VIR	1.2	SHA	158.9658	0.0017	-0.0118	-0.0052	0.0012	158.9605
		SPICA	B2	DEC	-11.0575	0.0016	-0.0048	-0.0020	0.0007	-11.0589
100		EPSILON CEN	2.6	SHA	155.3471	-0.0002	-0.0138	-0.0085	0.0026	155.3374
			B1	DEC	-53.3653	0.0018	-0.0047	-0.0003	0.0042	-53.3700
101	34	ETA UMA	1.9	SHA	153.3117	0.0040	-0.0093	-0.0077	0.0026	153.3083
		ALKAID	B3	DEC	49.4125	0.0018	-0.0046	-0.0025	-0.0044	49.4164
102		ETA BOO	2.8	SHA	151.5671	0.0026	-0.0108	-0.0053	0.0020	151.5623
			G0	DEC	18.4975	0.0019	-0.0046	-0.0026	-0.0021	18.4991
103		ZETA CEN	3.1	SHA	151.4292	0.0004	-0.0137	-0.0073	0.0028	151.4199
			B2	DEC	-47.1906	0.0019	-0.0046	-0.0003	0.0037	-47.1946
104	35	BETA CEN	0.9	SHA	149.4000	-0.0005	-0.0153	-0.0099	0.0042	149.3876
		HADAR	B1	DEC	-60.2772	0.0019	-0.0045	0.0004	0.0044	-60.2820
105	36	THETA CEN	2.3	SHA	148.6250	0.0010	-0.0132	-0.0061	0.0027	148.6167
		MENKENT	K0	DEC	-36.2722	0.0019	-0.0045	-0.0007	0.0028	-36.2753
106	37	ALPHA BOO	0.2	SHA	146.3129	0.0026	-0.0106	-0.0051	0.0025	146.3076
		ARCTURUS	K0	DEC	19.2858	0.0020	-0.0044	-0.0028	-0.0021	19.2877
107		GAMMA BOO	3.0	SHA	142.1821	0.0030	-0.0093	-0.0059	0.0035	142.1770
			F0	DEC	38.3950	0.0021	-0.0042	-0.0032	-0.0034	38.3984
108		ETA CEN	2.6	SHA	141.4425	0.0010	-0.0140	-0.0062	0.0038	141.4327
			*	DEC	-42.0706	0.0021	-0.0042	-0.0000	0.0030	-42.0736
109	38	ALPHA CEN A	0.3	SHA	140.4392	-0.0000	-0.0166	-0.0094	0.0059	140.4249
		RIGEL KENT.	G0	DEC	-60.7511	0.0021	-0.0041	0.0011	0.0041	-60.7551
110		ALPHA CEN B	1.7	SHA	140.4454	-0.0000	-0.0166	-0.0094	0.0059	140.4312
			K5	DEC	-60.7564	0.0021	-0.0041	0.0011	0.0041	-60.7604
111		ALPHA LUP	2.9	SHA	139.8521	0.0008	-0.0147	-0.0067	0.0043	139.8413
			B2	DEC	-47.3033	0.0021	-0.0041	0.0004	0.0033	-47.3065
112		EPSILON BOO	2.7	SHA	138.9717	0.0026	-0.0100	-0.0051	0.0034	138.9659
			K0	DEC	27.1578	0.0022	-0.0040	-0.0032	-0.0025	27.1605

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
113	39	ALPHA-2 LIB	2.9	SHA	137.5579	0.0018	-0.0124	-0.0046	0.0033	137.5502
		ZUBENELGENUBI	A3	DEC	-15.9594	0.0022	-0.0040	-0.0014	0.0009	-15.9602
114	40	BETA UMI	2.2	SHA	137.3125	0.0058	-0.0006	-0.0164	0.0116	137.3064
		KOCHAB	K5	DEC	74.2372	0.0022	-0.0040	-0.0033	-0.0047	74.2421
115		BETA LUP	2.8	SHA	135.6967	0.0011	-0.0145	-0.0060	0.0045	135.6861
			B2	DEC	-43.0544	0.0022	-0.0039	0.0003	0.0029	-43.0570
116		BETA LIB	2.7	SHA	131.0179	0.0019	-0.0121	-0.0042	0.0037	131.0101
			B8	DEC	-9.3100	0.0023	-0.0036	-0.0017	0.0003	-9.3098
117		GAMMA TRA	3.1	SHA	130.7442	0.0000	-0.0205	-0.0112	0.0101	130.7239
			A0	DEC	-68.6069	0.0023	-0.0036	0.0022	0.0039	-68.6103
118		GAMMA UMI	3.1	SHA	129.8125	0.0044	-0.0005	-0.0130	0.0120	129.8046
			A2	DEC	71.9050	0.0023	-0.0035	-0.0039	-0.0042	71.9097
119		GAMMA LUP	2.9	SHA	126.5496	0.0015	-0.0148	-0.0051	0.0053	126.5384
			B3	DEC	-41.1006	0.0023	-0.0033	0.0007	0.0024	-41.1022
120	41	ALPHA CRB	2.3	SHA	126.5400	0.0024	-0.0096	-0.0043	0.0045	126.5331
		ALPHECCA	A0	DEC	26.7811	0.0023	-0.0033	-0.0036	-0.0022	26.7840
121		ALPHA SER	2.7	SHA	124.1800	0.0021	-0.0111	-0.0037	0.0042	124.1724
			K0	DEC	6.4875	0.0024	-0.0031	-0.0026	-0.0008	6.4891
122		BETA TRA	3.0	SHA	121.6583	0.0012	-0.0196	-0.0079	0.0096	121.6402
			F0	DEC	-63.3706	0.0024	-0.0030	0.0025	0.0031	-63.3728
123		PI SCO	3.0	SHA	120.5904	0.0019	-0.0135	-0.0038	0.0049	120.5807
			B2	DEC	-26.0575	0.0024	-0.0029	-0.0003	0.0012	-26.0578
124		DELTA SCO	2.5	SHA	120.2133	0.0019	-0.0132	-0.0037	0.0048	120.2039
		DSCHUBBA	B0	DEC	-22.5658	0.0024	-0.0029	-0.0005	0.0010	-22.5659
125		BETA-1 SCO	2.9	SHA	118.9325	0.0020	-0.0130	-0.0035	0.0048	118.9232
			B1	DEC	-19.7517	0.0024	-0.0028	-0.0007	0.0008	-19.7515
126		DELTA OPH	3.0	SHA	116.6763	0.0021	-0.0118	-0.0032	0.0046	116.6678
			M0	DEC	-3.6439	0.0024	-0.0026	-0.0020	-0.0002	-3.6426
127		ETA DRA	2.9	SHA	114.0708	0.0023	-0.0034	-0.0063	0.0100	114.0614
			G5	DEC	61.5592	0.0024	-0.0024	-0.0048	-0.0029	61.5633
128	42	ALPHA SCO A	1.2	SHA	112.9554	0.0020	-0.0137	-0.0032	0.0054	112.9452
		ANTARES	M0	DEC	-26.3886	0.0024	-0.0023	-0.0001	0.0010	-26.3883
129		BETA HER	2.8	SHA	112.6604	0.0021	-0.0097	-0.0031	0.0052	112.6524
			K0	DEC	21.5322	0.0024	-0.0023	-0.0037	-0.0015	21.5350
130		TAU SCO	2.9	SHA	111.3417	0.0021	-0.0139	-0.0032	0.0056	111.3312
			B0	DEC	-28.1758	0.0024	-0.0022	0.0001	0.0010	-28.1755
131		ZETA OPH	2.7	SHA	110.9863	0.0021	-0.0123	-0.0028	0.0050	110.9772
			B0	DEC	-10.5278	0.0024	-0.0022	-0.0014	0.0001	-10.5266
132		ZETA HER	3.0	SHA	109.8671	0.0020	-0.0087	-0.0031	0.0058	109.8589
			G0	DEC	31.6381	0.0024	-0.0021	-0.0043	-0.0018	31.6412
133	43	ALPHA TRA	1.9	SHA	108.3663	0.0024	-0.0235	-0.0071	0.0141	108.3429
		ATRIA	K2	DEC	-68.9931	0.0024	-0.0020	0.0035	0.0023	-68.9939
134		EPSILON SCO	2.4	SHA	107.7838	0.0022	-0.0147	-0.0030	0.0061	107.7725
			K0	DEC	-34.2581	0.0024	-0.0019	0.0007	0.0011	-34.2577
135		ZETA ARA	3.1	SHA	105.7604	0.0024	-0.0185	-0.0042	0.0092	105.7444
			K5	DEC	-55.9600	0.0024	-0.0017	0.0026	0.0018	-55.9602

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					o	o	o	o	o	o
136	44	ETA OPH	2.6	SHA	102.6929	0.0022	-0.0128	-0.0022	0.0055	102.6832
		SABIK	A2	DEC	-15.7014	0.0024	-0.0015	-0.0008	0.0002	-15.6999
137		ALPHA HER	3-4	SHA	101.5667	0.0020	-0.0103	-0.0020	0.0055	101.5580
			M3	DEC	14.4122	0.0024	-0.0014	-0.0034	-0.0009	14.4148
138		BETA ARA	2.8	SHA	99.0921	0.0028	-0.0186	-0.0031	0.0095	99.0761
			K2	DEC	-55.5128	0.0024	-0.0012	0.0028	0.0012	-55.5122
139		UPSILON SCO	2.8	SHA	97.6496	0.0025	-0.0152	-0.0021	0.0068	97.6376
			B3	DEC	-37.2814	0.0024	-0.0011	0.0012	0.0007	-37.2802
140		BETA DRA	3.0	SHA	97.5054	0.0013	-0.0052	-0.0027	0.0089	97.4952
			G0	DEC	52.3156	0.0024	-0.0011	-0.0053	-0.0015	52.3189
141		ALPHA ARA	3.0	SHA	97.4271	0.0028	-0.0173	-0.0025	0.0085	97.4128
			B3	DEC	-49.8619	0.0024	-0.0010	0.0024	0.0010	-49.8611
142	45	LAMBDA SCO	1.7	SHA	96.9379	0.0025	-0.0152	-0.0020	0.0068	96.9260
		SHAULA	B2	DEC	-37.0906	0.0023	-0.0010	0.0012	0.0006	-37.0893
143	46	ALPHA OPH	2.1	SHA	96.4988	0.0019	-0.0104	-0.0016	0.0056	96.4899
		RASALHAGUE	A5	DEC	12.5736	0.0023	-0.0010	-0.0033	-0.0007	12.5762
144		THETA SCO	2.0	SHA	96.0304	0.0027	-0.0161	-0.0021	0.0075	96.0176
			F0	DEC	-42.9867	0.0023	-0.0009	0.0018	0.0007	-42.9855
145		KAPPA SCO	2.5	SHA	94.7246	0.0026	-0.0155	-0.0018	0.0071	94.7124
			B2	DEC	-39.0211	0.0023	-0.0008	0.0014	0.0005	-39.0197
146		BETA OPH	2.9	SHA	94.3792	0.0020	-0.0111	-0.0014	0.0055	94.3701
			K0	DEC	4.5744	0.0023	-0.0008	-0.0026	-0.0005	4.5769
147	47	GAMMA DRA	2.4	SHA	90.9650	0.0010	-0.0052	-0.0017	0.0090	90.9544
		ELTANIN	K5	DEC	51.4908	0.0023	-0.0005	-0.0054	-0.0010	51.4939
148		GAMMA SGR	3.1	SHA	88.8696	0.0026	-0.0144	-0.0010	0.0065	88.8585
			K0	DEC	-30.4258	0.0022	-0.0003	0.0007	0.0001	-30.4238
149		DELTA SGR	2.8	SHA	85.0717	0.0027	-0.0144	-0.0006	0.0065	85.0606
			K0	DEC	-29.8381	0.0022	0.0000	0.0007	-0.0001	-29.8357
150	48	EPSILON SGR	1.9	SHA	84.2892	0.0028	-0.0149	-0.0006	0.0069	84.2777
		KAUS AUST.	A0	DEC	-34.3956	0.0022	0.0001	0.0011	-0.0001	-34.3932
151		LAMBDA SGR	2.9	SHA	83.3163	0.0026	-0.0139	-0.0004	0.0063	83.3056
			K0	DEC	-25.4342	0.0021	0.0002	0.0002	-0.0002	-25.4317
152	49	ALPHA LYR	0.1	SHA	80.9350	0.0011	-0.0075	-0.0002	0.0073	80.9250
		VEGA	A0	DEC	38.7642	0.0021	0.0004	-0.0050	-0.0003	38.7667
153	50	SIGMA SGR	2.1	SHA	76.4938	0.0028	-0.0140	0.0003	0.0063	76.4832
		NUNKI	B3	DEC	-26.3228	0.0020	0.0008	0.0003	-0.0005	-26.3199
154		ZETA SGR	2.7	SHA	74.6654	0.0029	-0.0143	0.0005	0.0065	74.6546
			A2	DEC	-29.9103	0.0019	0.0009	0.0007	-0.0006	-29.9072
155		ZETA AQL	3.0	SHA	73.8775	0.0017	-0.0103	0.0005	0.0058	73.8683
			A0	DEC	13.8328	0.0019	0.0010	-0.0034	-0.0002	13.8354
156		PI SGR	3.0	SHA	72.8567	0.0027	-0.0134	0.0006	0.0060	72.8466
			F2	DEC	-21.0567	0.0019	0.0011	-0.0002	-0.0006	-21.0536
157		BETA-1 CYG	3.2	SHA	67.5217	0.0012	-0.0090	0.0012	0.0063	67.5121
		ALBIREO	*	DEC	27.9167	0.0017	0.0015	-0.0044	0.0003	27.9189
158		DELTA CYG	3.0	SHA	63.9129	0.0003	-0.0068	0.0020	0.0077	63.9021
			A0	DEC	45.0811	0.0016	0.0018	-0.0052	0.0009	45.0828

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					°	°	°	°	°	°
159		GAMMA AQL	2.8	SHA	63.6729	0.0017	-0.0106	0.0014	0.0055	63.6638
			K2	DEC	10.5636	0.0016	0.0019	-0.0031	-0.0001	10.5662
160	51	ALPHA AQL	0.9	SHA	62.5483	0.0018	-0.0108	0.0015	0.0055	62.5393
		ALTAIR	A5	DEC	8.8144	0.0016	0.0019	-0.0030	-0.0001	8.8171
161		GAMMA CYG	2.3	SHA	54.6229	0.0003	-0.0079	0.0029	0.0067	54.6127
			F8	DEC	40.1919	0.0013	0.0026	-0.0048	0.0013	40.1932
162	52	ALPHA PAV	2.1	SHA	53.9821	0.0052	-0.0180	0.0041	0.0092	53.9690
		PEACOCK	B3	DEC	-56.8006	0.0013	0.0026	0.0027	-0.0024	-56.7956
163		ALPHA IND	3.2	SHA	50.9592	0.0044	-0.0160	0.0037	0.0073	50.9483
			K0	DEC	-47.3625	0.0012	0.0028	0.0019	-0.0024	-47.3575
164	53	ALPHA CYG	1.3	SHA	49.8129	-0.0001	-0.0074	0.0037	0.0069	49.8022
		DENEB	A2	DEC	45.2083	0.0011	0.0029	-0.0048	0.0018	45.2091
165		EPSILON CYG	2.6	SHA	48.6500	0.0006	-0.0088	0.0032	0.0058	48.6404
			K0	DEC	33.8947	0.0011	0.0030	-0.0044	0.0014	33.8959
166		ALPHA CEP	2.6	SHA	40.4746	-0.0023	-0.0047	0.0071	0.0094	40.4605
		ALDERAMIN	A5	DEC	62.5006	0.0008	0.0035	-0.0046	0.0031	62.5000
167		BETA AQR	3.1	SHA	37.3738	0.0023	-0.0118	0.0035	0.0041	37.3660
			G0	DEC	-5.6597	0.0007	0.0037	-0.0018	-0.0008	-5.6564
168	54	EPSILON PEG	2.5	SHA	34.1996	0.0017	-0.0110	0.0038	0.0039	34.1918
		ENIF	K0	DEC	9.7828	0.0005	0.0039	-0.0028	0.0003	9.7849
169		DELTA CAP	3.0	SHA	33.5158	0.0028	-0.0124	0.0039	0.0040	33.5084
			A5	DEC	-16.2186	0.0005	0.0039	-0.0011	-0.0015	-16.2146
170	55	ALPHA GRU	2.2	SHA	28.2558	0.0047	-0.0144	0.0060	0.0051	28.2482
		AL NA'IR	B5	DEC	-47.0586	0.0003	0.0042	0.0009	-0.0036	-47.0527
171		ALPHA TUC	2.9	SHA	25.7146	0.0063	-0.0160	0.0085	0.0065	25.7064
			K2	DEC	-60.3600	0.0002	0.0043	0.0016	-0.0042	-60.3534
172		BETA GRU	2.2	SHA	19.6308	0.0047	-0.0137	0.0066	0.0040	19.6247
			M3	DEC	-46.9897	-0.0001	0.0046	0.0004	-0.0039	-46.9836
173	56	ALPHA PSA	1.3	SHA	15.8633	0.0035	-0.0125	0.0054	0.0028	15.8578
		FOMALHAUT	A3	DEC	-29.7286	-0.0002	0.0047	-0.0008	-0.0029	-29.7236
174		BETA PEG	2.6	SHA	14.2996	0.0008	-0.0106	0.0054	0.0025	14.2925
		SCHEAT	M0	DEC	27.9742	-0.0003	0.0047	-0.0030	0.0021	27.9741
175	57	ALPHA PEG	2.6	SHA	14.0596	0.0014	-0.0111	0.0049	0.0023	14.0532
		MARKAB	A0	DEC	15.0972	-0.0003	0.0048	-0.0027	0.0010	15.0983
176		GAMMA CEP	3.4	SHA	5.3717	-0.0085	-0.0076	0.0233	0.0065	5.3529
			K0	DEC	77.5208	-0.0007	0.0049	-0.0019	0.0053	77.5173

ALMANAC FOR COMPUTERS

A/C 81

NAUTICAL ALMANAC OFFICE
U. S. NAVAL OBSERVATORY

ALMANAC
FOR
COMPUTERS
1981

Nautical Almanac Office
United States Naval Observatory
Washington, D. C. 20390

Table of Contents

Section A: EXPLANATION

Introduction

The *Almanac for Computers* provides astronomical data in a form to facilitate the application of small computers and calculators to navigation and positional astronomy. This edition, *A/C 81*, employs the basic methods established in previous editions. Instead of the fixed-interval tabulations of *The Astronomical Almanac* (A^2), *The Nautical Almanac* (*NA*) and *The Air Almanac* (*AA*), concise mathematical expressions are used to represent the coordinates of celestial bodies for specified intervals of time. These expressions are necessarily approximations, because the fundamental equations of dynamical astronomy are too complex for direct use in the majority of applications. With minimal loss of precision the expressions in this volume will allow direct calculation of astronomical and navigational data for specific times and conditions. Further information concerning the precision of the approximations is given in Tables 1, 2 and 3 (pages A7, A9 and A11).

To simplify use of the power and Chebyshev series, a new relation for computing the normalized time x is introduced on pages A5 and A8. This new relation is particularly advantageous if data is entered in the calculator by hand. However, the method of previous editions can still be used.

A new algorithm for computing atmospheric refraction is presented on page B15. This method was developed by Dick Lewis of Balboa, California, to represent refraction for surface observations under standard atmospheric conditions. Given these restrictions, the algorithm provides high accuracy over a wide range of altitudes. It can be easily programmed for extremely efficient calculations.

For most efficient use with computers, the data in Sections D and E are available on punched cards or magnetic tape (data in Section C are not available in machine readable form). Inquiries about this service, as well as comments and suggestions concerning this volume, should be address to The Director, Nautical Almanac Office, U. S. Naval Observatory, Washington, D. C. 20390.

This volume was produced by LeRoy E. Doggett and Linda R. Gardner.

CALENDAR, 1981

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
Day of Month	Day of Week	Day of Year	Day of Week	Day of Year	Day of Week	Day of Year	Day of Week	Day of Year	Day of Week	Day of Year	Day of Week	Day of Year
1	Thu.	1	Sun.	32	Sun.	60	Wed.	91	Fri.	121	Mon.	152
2	Fri.	2	Mon.	33	Mon.	61	Thu.	92	Sat.	122	Tue.	153
3	Sat.	3	Tue.	34	Tue.	62	Fri.	93	Sun.	123	Wed.	154
4	Sun.	4	Wed.	35	Wed.	63	Sat.	94	Mon.	124	Thu.	155
5	Mon.	5	Thu.	36	Thu.	64	Sun.	95	Tue.	125	Fri.	156
6	Tue.	6	Fri.	37	Fri.	65	Mon.	96	Wed.	126	Sat.	157
7	Wed.	7	Sat.	38	Sat.	66	Tue.	97	Thu.	127	Sun.	158
8	Thu.	8	Sun.	39	Sun.	67	Wed.	98	Fri.	128	Mon.	159
9	Fri.	9	Mon.	40	Mon.	68	Thu.	99	Sat.	129	Tue.	160
10	Sat.	10	Tue.	41	Tue.	69	Fri.	100	Sun.	130	Wed.	161
11	Sun.	11	Wed.	42	Wed.	70	Sat.	101	Mon.	131	Thu.	162
12	Mon.	12	Thu.	43	Thu.	71	Sun.	102	Tue.	132	Fri.	163
13	Tue.	13	Fri.	44	Fri.	72	Mon.	103	Wed.	133	Sat.	164
14	Wed.	14	Sat.	45	Sat.	73	Tue.	104	Thu.	134	Sun.	165
15	Thu.	15	Sun.	46	Sun.	74	Wed.	105	Fri.	135	Mon.	166
16	Fri.	16	Mon.	47	Mon.	75	Thu.	106	Sat.	136	Tue.	167
17	Sat.	17	Tue.	48	Tue.	76	Fri.	107	Sun.	137	Wed.	168
18	Sun.	18	Wed.	49	Wed.	77	Sat.	108	Mon.	138	Thu.	169
19	Mon.	19	Thu.	50	Thu.	78	Sun.	109	Tue.	139	Fri.	170
20	Tue.	20	Fri.	51	Fri.	79	Mon.	110	Wed.	140	Sat.	171
21	Wed.	21	Sat.	52	Sat.	80	Tue.	111	Thu.	141	Sun.	172
22	Thu.	22	Sun.	53	Sun.	81	Wed.	112	Fri.	142	Mon.	173
23	Fri.	23	Mon.	54	Mon.	82	Thu.	113	Sat.	143	Tue.	174
24	Sat.	24	Tue.	55	Tue.	83	Fri.	114	Sun.	144	Wed.	175
25	Sun.	25	Wed.	56	Wed.	84	Sat.	115	Mon.	145	Thu.	176
26	Mon.	26	Thu.	57	Thu.	85	Sun.	116	Tue.	146	Fri.	177
27	Tue.	27	Fri.	58	Fri.	86	Mon.	117	Wed.	147	Sat.	178
28	Wed.	28	Sat.	59	Sat.	87	Tue.	118	Thu.	148	Sun.	179
29	Thu.	29			Sun.	88	Wed.	119	Fri.	149	Mon.	180
30	Fri.	30			Mon.	89	Thu.	120	Sat.	150	Tue.	181
31	Sat.	31			Tue.	90			Sun.	151		

JULIAN DATE, 1981

0^h UT		0^h UT		0^h UT		0^h UT	
Jan. 0	244 4604·5	Apr. 0	244 4694·5	July 0	244 4785·5	Oct. 0	244 4877·5
Feb. 0	244 4635·5	May 0	244 4724·5	Aug. 0	244 4816·5	Nov. 0	244 4908·5
Mar. 0	244 4663·5	June 0	244 4755·5	Sept. 0	244 4847·5	Dec. 0	244 4938·5

400-day date: JD 244 4800·5 = 1981 July 15·0

Standard epoch, 1900 January 0, 12^h UT = JD 241 5020·000
Standard epoch, 1950·0 = 1950 Jan. 0·923 = JD 243 3282·423
1981·0 = 1981 Jan. 0·432 = JD 244 4604·932

Day of Month	JULY Day of Week	JULY Day of Year	AUGUST Day of Week	AUGUST Day of Year	SEPTEMBER Day of Week	SEPTEMBER Day of Year	OCTOBER Day of Week	OCTOBER Day of Year	NOVEMBER Day of Week	NOVEMBER Day of Year	DECEMBER Day of Week	DECEMBER Day of Year
1	Wed.	182	Sat.	213	Tue.	244	Thu.	274	Sun.	305	Tue.	335
2	Thu.	183	Sun.	214	Wed.	245	Fri.	275	Mon.	306	Wed.	336
3	Fri.	184	Mon.	215	Thu.	246	Sat.	276	Tue.	307	Thu.	337
4	Sat.	185	Tue.	216	Fri.	247	Sun.	277	Wed.	308	Fri.	338
5	Sun.	186	Wed.	217	Sat.	248	Mon.	278	Thu.	309	Sat.	339
6	Mon.	187	Thu.	218	Sun.	249	Tue.	279	Fri.	310	Sun.	340
7	Tue.	188	Fri.	219	Mon.	250	Wed.	280	Sat.	311	Mon.	341
8	Wed.	189	Sat.	220	Tue.	251	Thu.	281	Sun.	312	Tue.	342
9	Thu.	190	Sun.	221	Wed.	252	Fri.	282	Mon.	313	Wed.	343
10	Fri.	191	Mon.	222	Thu.	253	Sat.	283	Tue.	314	Thu.	344
11	Sat.	192	Tue.	223	Fri.	254	Sun.	284	Wed.	315	Fri.	345
12	Sun.	193	Wed.	224	Sat.	255	Mon.	285	Thu.	316	Sat.	346
13	Mon.	194	Thu.	225	Sun.	256	Tue.	286	Fri.	317	Sun.	347
14	Tue.	195	Fri.	226	Mon.	257	Wed.	287	Sat.	318	Mon.	348
15	Wed.	196	Sat.	227	Tue.	258	Thu.	288	Sun.	319	Tue.	349
16	Thu.	197	Sun.	228	Wed.	259	Fri.	289	Mon.	320	Wed.	350
17	Fri.	198	Mon.	229	Thu.	260	Sat.	290	Tue.	321	Thu.	351
18	Sat.	199	Tue.	230	Fri.	261	Sun.	291	Wed.	322	Fri.	352
19	Sun.	200	Wed.	231	Sat.	262	Mon.	292	Thu.	323	Sat.	353
20	Mon.	201	Thu.	232	Sun.	263	Tue.	293	Fri.	324	Sun.	354
21	Tue.	202	Fri.	233	Mon.	264	Wed.	294	Sat.	325	Mon.	355
22	Wed.	203	Sat.	234	Tue.	265	Thu.	295	Sun.	326	Tue.	356
23	Thu.	204	Sun.	235	Wed.	266	Fri.	296	Mon.	327	Wed.	357
24	Fri.	205	Mon.	236	Thu.	267	Sat.	297	Tue.	328	Thu.	358
25	Sat.	206	Tue.	237	Fri.	268	Sun.	298	Wed.	329	Fri.	359
26	Sun.	207	Wed.	238	Sat.	269	Mon.	299	Thu.	330	Sat.	360
27	Mon.	208	Thu.	239	Sun.	270	Tue.	300	Fri.	331	Sun.	361
28	Tue.	209	Fri.	240	Mon.	271	Wed.	301	Sat.	332	Mon.	362
29	Wed.	210	Sat.	241	Tue.	272	Thu.	302	Sun.	333	Tue.	363
30	Thu.	211	Sun.	242	Wed.	273	Fri.	303	Mon.	334	Wed.	364
31	Fri.	212	Mon.	243			Sat.	304			Thu.	365

SIDEREAL TIME, 1981

Greenwich sidereal time at 0^h UT

	h m		h m		h m		h m
Jan. 0	06 38·3	Apr. 0	12 33·1	July 0	18 31·9	Oct. 0	00 34·6
Feb. 0	08 40·5	May 0	14 31·4	Aug. 0	20 34·1	Nov. 0	02 36·8
Mar. 0	10 30·9	June 0	16 33·6	Sept. 0	22 36·3	Dec. 0	04 35·1

Greenwich sidereal time (GST) at hour t UT on day d of month
$= \text{GST at } 0^h \text{ UT on day } 0 + 0^h{\cdot}0657\, d + 1^h{\cdot}0027\, t$

$$\text{Local sidereal time} = \text{GST} \begin{matrix} + \text{ east} \\ - \text{ west} \end{matrix} \text{ longitude}$$

Navigational Tables

Section C contains mathematical representations of the following functions that are tabulated in the *Nautical Almanac* (*NA*): the GHA of Aries, the GHA and declination of the Sun, Moon and navigational planets, the semidiameter of the Sun and Moon, and the horizontal parallax of the Moon. These functions are expressed for a specified time span by a power series of the form

$$f(x) = a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + a_5x^5$$

In the series x is a time-like variable that takes on values between -1 and $+1$ over the specified time span; $a_0, a_1, a_2, a_3, a_4, a_5$, are coefficients that are tabulated in Section C for the specified time span; and $f(x)$ represents the value of the function (*e.g.*, the GHA of Aries) evaluated at time x.

To evaluate the series for one of the navigational functions, one must first find the set of coefficients in Section C that is applicable for the desired date. As in previous editions, constants A and B are given for the purpose of converting the calendar date and GMT to the time-like variable x. An alternative and simpler method makes use of the constant W, which is also given. To obtain the value of x for the desired time, first determine t, the GMT measured in days and fractions thereof from 0 January, 0^h GMT, from the relation $t = N + \mathrm{GMT}/24$, where N is the day of the year at Greenwich and GMT is the Greenwich Mean Time expressed in hours. A calendar is provided on pages A2–A3 for finding the day of the year; alternatively the day of the year can be computed from the formulas given on pages B1 and B2. Once t has been determined, x can be computed either from the relation $x = (t - W)/A - 1$ or from $x = t/A + B$. The use of the first of these relations is generally preferable, particularly if the constants are entered by hand. If computed correctly, the value of x will fall in the range of $-1 \leqslant x \leqslant +1$.

Example 1: Compute x for later use in computing the position of the Sun at $10^h 11^m 00^s$ GMT ($=0^d\!.4243056$) on 25 December 1981.
From the calendar 25 December is found to be day 359. Thus $t = 359 + 0.4243056$. This date is in the interval 30 November through 31 December (days 334–365) for which coefficients for the Sun are given on page C6. The constants for this interval are $A = 16.0$ and $W = 334$. Therefore
$x = (359.4243056 - 334)/16.0 - 1 = +0.5890191$.

Once the variable x has been computed and the coefficients a_i have been found, the series $f(x) = a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + a_5x^5$ can be evaluated. The series can be evaluated most efficiently by computing a set of five auxiliary variables, b_1, b_2, b_3, b_4, b_5, in the following order:

$$\begin{aligned}
b_5 &= xa_5 \\
b_4 &= x(a_4 + b_5) \\
b_3 &= x(a_3 + b_4) \\
b_2 &= x(a_2 + b_3) \\
b_1 &= x(a_1 + b_2) \\
f(x) &= a_0 + b_1
\end{aligned}$$

By using this algorithm, the series is evaluated in its nested form

$$f(x) = a_0 + x(a_1 + x(a_2 + x(a_3 + x(a_4 + xa_5)))).$$

Example 2: Compute the GHA of the Sun at $10^h 11^m 00^s$ GMT on 25 December 1981.

From the previous example $x = +0.5890191$. The coefficients for the Sun's GHA are found on page C6.

$$\begin{aligned}
b_5 &= .5890191\ (0.0060) &&= +0.0035 \\
b_4 &= .5890191\ (0.0069 + 0.0035) &&= +0.0061 \\
b_3 &= .5890191\ (0.0797 + 0.0061) &&= +0.0505 \\
b_2 &= .5890191\ (-0.1297 + 0.0505) &&= -0.0467 \\
b_1 &= .5890191\ (5758.0672 - 0.0467) &&= +3391.5841 \\
f(+0.5890191) &= 5941.1443 + 3391.5841 &&= +9332.7284
\end{aligned}$$

GHA = $332\overset{\circ}{.}7284 = 332° 43\overset{\prime}{.}7$

Note that when computing the GHA, it may be necessary to reduce the final result to the range 0° – 360° by subtracting multiples of 360°.

Example 3: Compute the declination of the Moon at $19^h 20^m 00^s$ GMT on 13 May 1981.

The constants A and W and series coefficients are found on page C13.

$x = (t - W)/A - 1 = (133.8055556 - 133)/3.0 - 1 = -0.7314815$

$$\begin{aligned}
b_5 &= -.7314815\ (0.0113) &&= -0.0083 \\
b_4 &= -.7314815\ (0.0020 - 0.0083) &&= +0.0046 \\
b_3 &= -.7314815\ (0.6311 + 0.0046) &&= -0.4650 \\
b_2 &= -.7314815\ (0.7711 - 0.4650) &&= -0.2239 \\
b_1 &= -.7314815\ (-12.5205 - 0.2239) &&= +9.3223 \\
f(-0.7314815) &= (-4.1010 + 9.3223) &&= +5.2213
\end{aligned}$$

declination = $+5° 13\overset{\prime}{.}3$

Although the series are designed to provide precision comparable to that published in the *NA*, there will be small discrepencies between the tabulated values and the values computed from the series. In such cases it should be understood that the *NA* represents the standard. Table 1 lists the largest discrepencies found from evaluating and comparing the series with the data in the *NA*.

Under no circumstances should the series be used to extrapolate data beyond the specified time intervals. Such extrapolation will lead to erroneous and useless results.

In accordance with standard practice for navigational almanacs, the time argument used in this almanac is Greenwich Mean Time (GMT), or more specifically UT1. To obtain full precision in the determined positions, the radio time signals in UTC must be corrected to UT1, or GMT, according to standard procedures. (See the paper by R.L. Duncombe and P.K. Seidelmann, 'The New UTC Time Signals', *Navigation*, **24**, 160–165, 1977.)

Beneath each set of coefficients in Section C is printed the sum of the coefficients. As a check on whether the coefficients have been entered accurately into the calculator, it is recommended that the coefficients be summed and that the resulting sum be compared with the printed sum.

Table 1: Comparison of *Almanac for Computers* with *NA*

Function			No. of Terms	Span of Validity	Maximum Error
GHA of Aries			6	32 days	0.′1
Sun:	GHA		"	"	0.′1
	Declination		"	"	0.′1
	Semi-Diameter		"	"	0.′1
Moon:	GHA		"	6 days	0.′2
	Declination		"	"	0.′2
	Horizontal Parallax		"	"	0.′1
	Semi-Diameter		"	"	0.′1
Navigational Planets:		GHA	"	32 days	0.′1
		Declination	"	"	0.′1

Astronomical Tables

Section D contains mathematical representations of data published in the *Astronomical Almanac* (A^2). Chebyshev expansions have been chosen as the means of representation since they provide efficient and accurate expressions that can be easily evaluated with a small computer. The coefficients a_i of the Chebyshev expansion

$$f(x) = a_0/2 + \sum_{i=1}^{n} a_i T_i(x)$$

are tabulated for prescribed time spans, where $f(x)$ is the function being represented, $T_i(x)$ is the Chebyshev polynomial of the first kind of the *i-th* degree, and x is the normalized time variable. Although Chebyshev polynomials appear in the series expansions, the series can be evaluated without explicitly computing these polynomials. No *a prori* knowledge of Chebyshev analysis is required to use the series in this almanac. Interested readers can find information on Chebyshev analysis in *Applied Analysis* by C. Lanczos and *Chebyshev Polynomials in Numerical Analysis* by L. Fox and I. B. Parker.

It must be emphasized that the series are valid only over the specified time intervals. Attempts to extrapolate data using these series will yield erroneous and useless results.

If precision comparable to that of the A^2 is required, the series on pages D2 – D29 should be used. With the exception of the series for the Moon, these series are valid for time spans of approximately three months; for the Moon the span of validity is approximately one month. Table 2 lists the largest errors found by evaluating these series and comparing the results with data printed in the A^2.

It is possible to develop series that are valid for longer time spans if the precision requirements are relaxed. Such series, valid for one full year, are given on pages D30 – D33. Precision criteria of these less precise series are summarized in Table 3.

To evaluate a Chebyshev series, one must first normalize the time variable on the interval for which the series is valid. The normalized time x can be determined either from the relation $x = (t - W)/A - 1$ or from $x = t/A + B$, where t is reckoned in days and fractions thereof from 0 January. As in previous editions, constants A and B are given for each set of coefficients. The constant W is also given for use in the first of the relations listed above. Use of the first relation is particularly recommended if data is entered by hand. If correctly computed, the value of x will fall in the range $-1 \leqslant x \leqslant +1$.

For the functions Apparent Sidereal Time at 0^h UT, Equation of the Equinoxes, Nutation in Longitude and Nutation in Latitude, the variable t is measured in days of universal time (UT1 to be precise) from 0 January, 0^h UT. For all other functions in Section D, t is measured in days of ephemeris time from 0 January, 0^h ET. These latter functions can be evaluated for universal times, however, by

Table 2: Comparison of *Almanac for Computers* and A^2
(High Precision Series, pp. D2 – D29)

Function		No. of Terms	Span of Validity	Maximum Error
Apparent Sidereal Time at 0^h UT		36	95 days	$0^s.001$
Equation of the Equinoxes		"	"	$0^s.001$
Nutation in Longitude		"	"	$0''.009$
Nutation in Obliquity		"	"	$0''.004$
Sun:	Right Ascension	24	95 days	$0^s.01$
	Declination	"	"	$0''.1$
	Distance	"	"	2×10^{-7} AU
	Semidiameter	"	"	$0''.01$
	Ephemeris Transit	"	"	$0^s.02$
Moon:	Right Ascension	34	32 days	$0^s.005$
	Declination	"	"	$0''.04$
	Horizontal Parallax	"	"	$0''.01$
	Geocentric Rectangular Coords.	"	"	1×10^{-6} Earth radii
Mercury:	Right Ascension	34	95 days	$0^s.02$
	Declination	"	"	$0''.2$
	Distance	"	"	1×10^{-6} AU
Venus:	Right Ascension	34	95 days	$0^s.01$
	Declination	"	"	$0''.1$
	Distance	"	"	1×10^{-6} AU
Mars:	Right Ascension	20	95 days	$0^s.02$
	Declination	"	"	$0''.1$
	Distance	"	"	1×10^{-6} AU
Jupiter:	Right Ascension	20	95 days	$0^s.01$
	Declination	"	"	$0''.1$
	Distance	"	"	1×10^{-6} AU
Saturn:	Right Ascension	14	95 days	$0^s.02$
	Declination	"	"	$0''.1$
	Distance	"	"	3×10^{-6} AU
Uranus:	Right Ascension	14	95 days	$0^s.02$
	Declination	"	"	$0''.1$
	Distance	"	"	3×10^{-6} AU
Neptune:	Right Ascension	12	95 days	$0^s.02$
	Declination	"	"	$0''.1$
	Distance	"	"	1×10^{-5} AU
Pluto:	Right Ascension (astrometric)	12	95 days	$0^s.004$
	Declination (astrometric)	"	"	$0''.04$
	Distance	"	"	9×10^{-6} AU

using either the normalizing relation $x = ((t' + \Delta T) - W)/A - 1$ or the relation $x = (t' + \Delta T)/A + B$, where t' is the universal time measured in days from 0 January, 0^h UT. As this volume goes to press, $\Delta T = 51\overset{s}{.}8$ ($=0\overset{d}{.}000600$) appears to be a reliable value to use in 1981. Care should be taken to verify that the sum $t' + \Delta T$ falls within the time span for which the series is valid; if it falls outside, the series and constants for the next span should be used.

Once the normalized time variable x is determined, the approximation

$$f(x) = a_0/2 + \sum_{i=1}^{n} a_i T_i(x)$$

where the a_i are the printed coefficients, can be evaluated as follows:

let $\quad b_{n+1} = b_{n+2} = 0,$

compute $\quad b_i = 2xb_{i+1} - b_{i+2} + a_i,$ for $i = n, n-1, \ldots, 0,$

then $\quad f(x) = (b_0 - b_2)/2.$

Example : Compute the equation of the equinoxes to a precision of $\pm 0\overset{s}{.}05$ at $10^h 10^m 00^s$ UT ($=0\overset{d}{.}423611$) on 10 July 1981.

As shown in Table 3 the low precision series on page D30 provide the required precision. From the calendar on pages A2–A3 or the formulas on pages B1 and B2, 10 July is found to be day 191. Since universal time is the independent variable for the series for the equation of the equinoxes,

$t = 191^d + 0\overset{d}{.}423611 = 191\overset{d}{.}423611$

Constants for the series are $A = 183.0$ and $W = 1$.

$x = (191.423611 - 1)/183.0 - 1 = +0.04056618$

$$\begin{aligned}
b_{n+2} &= b_{11} = 0 \\
b_{n+1} &= b_{10} = 0 \\
b_n &= b_9 = 2xb_{10} - b_{11} + a_9 = +0.0054 \\
&\quad b_8 = 2xb_9 - b_{10} + a_8 = +0.0049 \\
&\quad b_7 = 2xb_8 - b_9 + a_7 = -0.0225 \\
&\quad b_6 = 2xb_7 - b_8 + a_6 = -0.0252 \\
&\quad b_5 = 2xb_6 - b_7 + a_5 = +0.0821 \\
&\quad b_4 = 2xb_5 - b_6 + a_4 = +0.0522 \\
&\quad b_3 = 2xb_4 - b_5 + a_3 = -0.0811 \\
&\quad b_2 = 2xb_3 - b_4 + a_2 = -0.0354 \\
&\quad b_1 = 2xb_2 - b_3 + a_1 = -0.0502 \\
&\quad b_0 = 2xb_1 - b_2 + a_0 = -1.7426 \\
f(x) &= (b_0 - b_2)/2 = (-1.7426 + 0.0354)/2
\end{aligned}$$

equation of the equinoxes $= -0\overset{s}{.}85$

Table 3: Comparison of *Almanac for Computers* and A^2
(Low Precision Series, pp. D30 – D33)

Function		No. of Terms	Maximum Error
Apparent Sidereal Time at 0^h UT		10	$0\overset{s}{.}03$
Equation of the Equinoxes		"	$0\overset{s}{.}03$
Nutation in Longitude		"	$0\overset{''}{.}5$
Nutation in Obliquity		"	$0\overset{''}{.}1$
Sun:	Right Ascension	22	$0\overset{s}{.}5$
	Declination	"	3″
	Distance	"	4×10^{-5} AU
	Semidiameter	"	$0\overset{''}{.}04$
	Ephemeris Transit	"	$0\overset{s}{.}5$
Mercury:	Right Ascension	50	15^s
	Declination	"	$2\overset{'}{.}9$
	Distance	"	4×10^{-4} AU
Venus:	Right Ascension	50	$0\overset{s}{.}03$
	Declination	"	$0\overset{''}{.}2$
	Distance	"	1×10^{-6} AU
Mars:	Right Ascension	22	$0\overset{s}{.}3$
	Declination	"	1″
	Distance	"	4×10^{-5} AU
Jupiter:	Right Ascension	22	$0\overset{s}{.}1$
	Declination	"	$0\overset{''}{.}6$
	Distance	"	3×10^{-5} AU
Saturn:	Right Ascension	16	$0\overset{s}{.}1$
	Declination	"	$0\overset{''}{.}4$
	Distance	"	4×10^{-5} AU
Uranus:	Right Ascension	16	$0\overset{s}{.}1$
	Declination	"	$0\overset{''}{.}3$
	Distance	"	4×10^{-5} AU
Neptune:	Right Ascension	14	$0\overset{s}{.}04$
	Declination	"	$0\overset{''}{.}2$
	Distance	"	4×10^{-5} AU
Pluto:	Right Ascension (astrometric)	14	$0\overset{s}{.}02$
	Declination (astrometric)	"	$0\overset{''}{.}1$
	Distance	"	5×10^{-5} AU

Beneath each set of coefficients is printed the sum of the coefficients. This may be used as an easy means of verifying the accuracy with which the coefficients have been entered in the computer.

The series for Apparent Sidereal Time are designed to reproduce the table 'Apparent Sidereal Time at 0^h Universal Time' in *The Astronomical Almanac*. To compute the Greenwich apparent sidereal for any universal time,

(1) evaluate the series for the desired UT,

(2) add the desired UT to the result of step (1).

Local apparent sidereal time may be obtained by subtracting the local longitude from the Greenwich apparent sidereal time, where west longitudes are considered positive.

With two exceptions the series in Section D provide data referred to the true equinox and equator of date. The exceptions are

(1) the Moon's geocentric, rectangular coordinates (X, Y, Z), which are referred to the mean equator and equinox of 1950.0;

(2) the right ascension and declination of Pluto, which are astrometric (*i.e.*, free of the effect of stellar aberration, except for the elliptic part) and are referred to the mean equinox and equator of 1950.0.

The unit of distance for the Sun and planets is the astronomical unit; the unit of distance for the Moon is the Earth's equatorial radius.

Stellar Tables

The Stellar Tables (Section E) list the mean and apparent places of 176 stars for the current year, along with coefficients for converting from mean to apparent place for any date in the year. The selection of stars is essentially that of the star tables on pages 268–273 of the *Nautical Almanac*. Stars are arranged in order of increasing right ascension (decreasing sidereal hour angle), except where both components of a binary system are listed. For binary stars that can be resolved in small instruments, the position of one or both components is listed rather than the position of the center of gravity or the center of light. When both components of a binary system are included, the brighter star is listed first. For convenience of navigators the sidereal hour angle (SHA) is tabulated rather than right ascension (RA); right ascension in degrees can be obtained from the relation

$$RA = 360^\circ - SHA.$$

The quantities tabulated for each star are, from left to right on the page:

1. Identification number.
2. Navigational star number, provided the star is one of the 57 selected navigational stars listed in the *Nautical Almanac* and *Air Almanac*.
3. Star name. The Bayer designation is on the first line and the proper name, if any, is on the second line.
4. Magnitude and spectral type. The visual magnitude is on the first line, and the spectral type is on the second line. A composite spectrum is denoted by *.
5. Mean place of the star for 1981.0. The SHA in degrees is on the first line; the declination in degrees is on the second line.
6. Four coefficients (H, R, S, C) used in computing the apparent place of the star. The coefficients on the first line are for the computation of apparent SHA; these will hereafter by designated H_S, R_S, S_S, C_S. The coefficients on the second line are for the computation of apparent declination; these will be designated with the subscript D: H_D, *etc.*
7. Apparent place of the star for the middle of the year. SHA in degrees is on the first line; declination is on the second line.

The mean place of a star is a fundamental reference point with no simple geometric or observational significance. The apparent place of a star is the geocentric position, referred to the true equinox and equator of date, at which the star is observed. Thus the apparent place is the position needed for navigation, calibration of telescope setting circles, computation of transit times, *etc*. Except for Polaris the tabulated apparent places for the middle of the year can be used to an accuracy of $\pm 1'.3$ for any date during the year. To obtain apparent places to greater accuracy, the following procedures should be used:

For the desired date in the current year determine τ, the fraction of the year elapsed. If t denotes the day of the year, τ can be computed either from the relation $\tau = (t - W)/A$ or from $\tau = t/A + B$. As in previous editions the constants A and B are given at the top of page E3. The constant W is also given there for use in the first of the above relations. The first relation is generally preferable, particularly if the constants are entered by hand.

Except for Polaris, star positions accurate to better than $\pm 0\overset{'}{.}5$ can be obtained from the following formulas:

$$\text{apparent SHA} = \text{mean SHA} + H_S + R_S\tau$$
$$\text{apparent decl.} = \text{mean decl.} + H_D + R_D\tau$$

Except for Polaris, star positions accurate to better than $\pm 0\overset{'}{.}1$ (and usually better than $\pm 0\overset{'}{.}05$) can be obtained from the following formulas:

$$\text{apparent SHA} = \text{mean SHA} + H_S + R_S\tau + S_S\sin(360°\tau) + C_S\cos(360°\tau)$$
$$\text{apparent decl.} = \text{mean decl.} + H_D + R_D\tau + S_D\sin(360°\tau) + C_D\cos(360°\tau)$$

The tabulated apparent places for the middle of the year were computed using the latter formulas with $\tau = 0.5$.

To facilitate identification of the 57 standard navigational stars, an index for these stars is provided on page E2.

Example: Compute the apparent place of Deneb (α Cygni) on 22 October to an accuracy of $\pm 0\overset{'}{.}1$.

From the calendar on pages A2–A3 or the formulas on pages B1–B2, 22 October is found to be day 295. From page E3, A = 365.0 and W = 1. Data for Deneb (Nav. No. 53; A/C ID 164) are found on page E10.

$$\tau = (295 - 1)/365.0 = +0.8055$$

	SHA	decl.
Mean place	49°8046	+45°2119
$+H$	+ 0.0010	+ 0.0004
$+R\tau$	– 0.0060	+ 0.0023
$+S\sin(360°\tau)$	– 0.0034	+ 0.0045
$+C\cos(360°\tau)$	+ 0.0024	+ 0.0006
Apparent place	49°799	+45°220

Because of the close proximity of Polaris to the north celestial pole, a small change in the position of Polaris on the celestial sphere causes a large change in the value of the SHA (or right ascension). This is purely due to the nature of the coordinate system rather than to extraordinary physical motion. Though the formulas given above will yield the declination of Polaris to an accuracy comparable to that of other stars, errors in SHA can reach $\pm 1\overset{'}{.}2$, even if the more accurate formula is used.

Section B: APPLICATIONS

Introduction

In this section reference will be made to the following functions:

Sign function. The sign function serves to extract the algebraic sign from a number. The notation sign(x) is defined to be $\mathrm{sign}(x) = 1$ for $x \geqslant 0$, $\mathrm{sign}(x) = -1$ for $x < 0$. An equivalent definition is $\mathrm{sign}(x) = x/|x|$ for $x \neq 0$, $\mathrm{sign}(x) = 1$ for $x = 0$.
Examples: $\mathrm{sign}(247) = 1$, $\mathrm{sign}(-6.28) = -1$.

Truncation or largest-integer function. The truncation function extracts the integral part of a number. The algebraic sign of the result is the same as that of the original number. $\langle x \rangle$ is defined to be $\langle x \rangle = \mathrm{sign}(x) \cdot N$, where N is the largest nonnegative integer such that $N \leqslant |x|$.
Examples: $\langle 17.835 \rangle = 17$, $\langle -3.1416 \rangle = -3$.

Modulus or remainder function. The modulus function yields the remainder of the division x/y, when the quotient is constrained to be an integral value. Thus mod(x,y) is defined to be $\mathrm{mod}(x,y) = x - \langle x/y \rangle \cdot y$.
Examples: $\mathrm{mod}(11,3) = 2$, $\mathrm{mod}(-764.3,360.0) = -44.3$.
Note that $\langle x \rangle = x - \mathrm{mod}(x,1.0)$. Therefore the truncation function can be defined in terms of the modulus function and *vice versa*. If either modulus or truncation is available on a calculator or computer, the other function can be simply obtained.

In this almanac universal time (UT) is to be identified with UT1, which is equivalent to the standard navigational time argument Greenwich Mean Time (GMT). The symbols UT and GMT may therefore be considered interchangable. For detailed information on time systems the reader should consult the Explanation of a current edition of *The Astronomical Almanac.*

Day of the Year

The day of the year (N) is defined as the integer $N = \langle t \rangle$, where t is the time elasped in days since 0 January of the current year. Thus N is an integer running from 1 through 365 (or 366 in leap years). The day of the year can be computed from either of the following formulas:

$$N = \left\langle \frac{275M}{9} \right\rangle - \left\langle \frac{M+9}{12} \right\rangle \left(1 + \left\langle \frac{K - 4\langle K/4 \rangle + 2}{3} \right\rangle \right) + I - 30$$

$$N = \left\langle \frac{275M}{9} \right\rangle - \left\langle \frac{M+9}{12} \right\rangle \left(1 + \left\langle \frac{\mathrm{mod}(K,4) + 2}{3} \right\rangle \right) + I - 30$$

where N is the day of the year, K is the year (*e.g.*, 1981), M is the month ($1 \leqslant M \leqslant 12$), and I is the day of the month ($1 \leqslant I \leqslant 31$).

These formulas are equivalent and are valid for any year, except those centennial years that are not evenly divisible by 400. Therefore the formulas given above are

valid for the year 2000, but not for 1900 or 2100. In the above formulas the factor within the parentheses has the value 1 for leap years and 2 for non-leap years. Thus for a non-leap year, the following expression can be used:

$$N = \left\langle \frac{275\,M}{9} \right\rangle - 2\left\langle \frac{M+9}{12} \right\rangle + I - 30$$

For leap years the corresponding expression is

$$N = \left\langle \frac{275\,M}{9} \right\rangle - \left\langle \frac{M+9}{12} \right\rangle + I - 30$$

Many expressions in this almanac require the value of t, the time elasped in days since 0 January, 0^h UT, of the current year. By inverting the definition of N, we obtain $t = N + UT/24$, where UT is the universal time expressed in hours.

Julian Date

The Julian Date (JD) is a continuous count of days and fractions thereof from 1 January 4713 B.C. (=–4712 January 1), Greenwich Mean Noon (=12^h UT). For example A.D. 1978 January 1, 0^h UT, is JD 2443509.5 and A.D. 1978 July 21, 15^h UT, is JD 2443711.125. Conversion of Gregorian Calendar Date to Julian Date for the years A.D. 1801 through A.D. 2099 can be carried out with the following formula:

$$\text{JD} = 367\,K - \left\langle \frac{7(K + \langle (M+9)/12 \rangle)}{4} \right\rangle + \left\langle \frac{275\,M}{9} \right\rangle + I + 1721013.5$$

$$+ \; UT\,/\,24 - 0.5\,\text{sign}\,(100\,K + M - 190002.5) + 0.5$$

where K is the year ($1801 \leqslant K \leqslant 2099$), M is the month ($1 \leqslant M \leqslant 12$), I is the day of the month ($1 \leqslant I \leqslant 31$), and UT is the universal time in hours. The last two terms in the formula add up to zero for all dates after 1900 February 28, so these two terms can be omitted for subsequent dates. Note that the formula makes use of the truncation and sign functions defined on page B1.

Example: Compute the JD corresponding to 1877 August 11, $7^h 30^m$ UT.
Substituting $K = 1877, M = 8, I = 11$, and $UT = 7.5$ in the formula yields
JD = 688859 – 3286 + 244 + 11 + 1721013.5 + 0.3125 + 0.5 + 0.5
= 2406842.8125

The Modified Julian Date (MJD) is sometimes used to specify current dates; it is defined as MJD = JD – 2400000.5. Use of the Modified Julian Date, rather than the Julian Date, is recommended with computers and calculators of limited precision. Note that for 0^h UT on any date the Julian Date has a fractional part of .5, while the corresponding Modified Julian Date is an integer.

If ephemeris time (ET) is used in the above formula instead of universal time (UT), the resulting quantity is designated Julian Ephemeris Date (JED).

Sidereal Time

The following formulas are relevant to the computation of sidereal time:

(1) $\text{GMST} = 6^{\text{h}}.63832206 + 0^{\text{h}}.0657098232N + 1.0027379093UT$

(2) $\text{GMST} = 6^{\text{h}}.67170278 + 0^{\text{h}}.0657098232(\text{JD0} - 2433282.5) + 1.0027379093UT$

(3) $\Omega = 132^{\circ}.5693 - 0^{\circ}.0529539\,(N + UT/24)$

(4) $\Omega = 372^{\circ}.1133 - 0^{\circ}.0529539\,(\text{JD} - 2433282.5)$

(5) $E = -0^{\text{h}}.00029 \sin\Omega$

(6) $\text{GAST} = \text{GMST} + E$

(7) $\text{GAST} = \Sigma(t_0) + 1.0027379093UT = \Sigma(t) + UT$

(8) $\text{LAST} = \text{GAST} - \lambda/15$

where

GMST is the Greenwich mean sidereal time in hours;

Ω is the mean longitude of the ascending node of the Moon's orbit, measured in degrees;

E is the equation of the equinoxes in hours;

GAST is the Greenwich apparent sidereal time in hours;

LAST is the local apparent sidereal time in hours;

N is the day of the year ($1 \leqslant N \leqslant 365$ or, during a leap year, $1 \leqslant N \leqslant 366$);

UT is the universal time in hours;

JD0 and JD are the Julian Dates at 0^{h} UT and at an arbitrary time of the day, respectively;

$\Sigma(t_0)$ and $\Sigma(t)$ are values obtained by evaluating the Chebyshev series for Apparent Sidereal Time (pp. D2–D5 or D30) at 0^{h} UT and at an arbitrary time of the day, respectively; (see page A12 for notes about evaluating the series for sidereal time)

λ is the local longitude in degrees (west is positive; east is negative).

When using the formulas given above, it may be necessary to reduce the results to the range $0^{\text{h}} - 24^{\text{h}}$ by adding or subtracting multiples of 24^{h}.

Formulas (1) and (3) are specifically for the current year; the other formulas are valid at least over the latter half of this century. Formula (5) is an approximation that is accurate to about $\pm 0^{\text{s}}.2$. If more accuracy is required, the Chebyshev series for the Equation of the Equinoxes (pp. D2–D5 or D30) can be used in place of Formula (5). If sidereal time is to be computed to an accuracy better than $\pm 0^{\text{s}}.2$ (rarely justified for practical applications), then *either* the Chebyshev series for the Equation of the Equinoxes should be used in place of Formula (5) *or* Formula (7) should be used in place of Formula (6).

These formulas can be easily adapted to allow the Modified Julian Date to be used in place of the Julian Date.

Hour Angles

The following formulas are useful if astronomical data, such as that given in Sections C and E, are applied to navigational purposes:

$$GHA = 15\,(GAST - RA)$$

$$LHA = 15\,(LAST - RA) = GHA - \lambda$$

$$GHA\ Aries = 15\ GAST$$

$$SHA = 360^\circ - 15\ RA$$

$$GHA = GHA\ Aries + SHA$$

where

GHA is the Greenwich hour angle in degrees;
LHA is the local hour angle in degrees;
GHA Aries is the Greenwich hour angle of the First Point of Aries (the origin of right ascension) in degrees;
SHA is the sidereal hour angle in degrees;
RA is the apparent right ascension (referred to the true equator and equinox of date) in hours;
λ is the local longitude in degrees (west is positive; east is negative)
GAST is the Greenwich apparent sidereal time in hours;
LAST is the local apparent sidereal time in hours.

When using the above formulas, it may be necessary to add or subtract 360° to reduce the resulting hour angles to the range 0° –360°. Often the local hour angle values are reduced to the range –180° to +180°, in which case they are called meridian angles. In all cases positive hour angle values are measured westward from the meridian.

Altitude and Azimuth

The following formulas can be used to compute the altitude (a) and azimuth (A) of a celestial body:

(1) $\sin a = \cos z = \sin\phi \sin\delta + \cos\phi \cos\delta \cos \mathrm{LHA}$

(2) $x = \tan A = \sin \mathrm{LHA} / (\cos \mathrm{LHA} \sin\phi - \tan\delta \cos\phi)$

Since computers and calculators normally give the arctangent in the range –90° to + 90°, the correct quadrant for A can be selected according to the following rules:

If $0^\circ \leqslant \mathrm{LHA} \leqslant 180^\circ$,

$A = 180^\circ + \arctan x$, if x is positive,
$A = 360^\circ + \arctan x$, if x is negative.

If $180^\circ \leqslant \mathrm{LHA} < 360^\circ$,

$A = \arctan x$, if x is positive,
$A = 180^\circ + \arctan x$, if x is negative.

Notation:

a = altitude of body above (if $\sin a > 0$) or below (if $\sin a < 0$) the horizon;
A = azimuth of body measured eastward from north over the range $0° \leqslant A \leqslant 360°$;
ϕ = latitude of observer (north is positive; south is negative);
δ = declination of body (north is positive; south is negative);
LHA = local hour angle of body;
z = zenith distance of body ($z = 90° - a$).

In standard navigational notation altitude and azimuth are denoted Hc and Zn, respectively. Equations (1) and (2) are the basic formulas used in preparing sight reduction tables; they do not include the effect of refraction.

Example: Compute the altitude and azimuth of the Sun at $14^h 02^m 14^s$ UT on 28 July at Northampton, Massachusetts.

Latitude: $\phi = +42.°3$ $\qquad \sin\phi = +0.67301$ $\qquad \cos\phi = +0.73963$

Longitude: $\lambda = +72.°6$

Using the power series on page C4, the Sun's GHA and δ are found to be

GHA $= 28.°956$ $\qquad$ hence $\qquad$ LHA $= 28.°956 - 72.°6 = 316.°356$

$\sin \text{LHA} = -0.69017$ $\qquad \cos \text{LHA} = +0.72364$

$\delta = +18.°922$ $\quad \sin\delta = +0.32428$ $\quad \cos\delta = +0.94596$ $\quad \tan\delta = +0.34281$

$\sin a = \cos z = (0.67301)(0.32428) + (0.73963)(0.94596)(0.72364)$
$= +0.72455$

$a = 46.°4$

$x = \tan A = (-0.69017)/((0.72364)(0.67301) - (0.34281)(0.73963))$
$= -2.9562$ $\qquad \arctan x = -71.°3$

Since LHA is greater than 180° and less than 360°, and since x is negative,
$A = 180° + (-71.°3) = 108.°7$

Sunrise, Sunset and Twilight

For locations between latitudes 65° North and 65° South, the following algorithm provides times of sunrise, sunset and twilight to an accuracy of $\pm 2^m$, for any date in the latter half of the twentieth century. Because the phenomena depend on local meteorological conditions, attempts to attain higher accuracy are seldom justified. Although the algorithm can be used at higher latitudes, its accuracy deteriorates near dates on which the Sun remains above or below the horizon for more than twenty-four hours.

Notation:

ϕ = latitude of observer (north is positive; south is negative)
λ = longitude of observer (west is positive; east is negative)
M = Sun's mean anomaly
L = Sun's true longitude

RA = Sun's right ascension
δ = Sun's declination
H = Sun's local hour angle
z = Sun's zenith distance at rise, set or twilight*
t = approximate time of phenomenon in days since 0 Jan., 0^h UT
T = local mean time of phenomenon
UT = universal time of phenomenon

*The proper value of z should be chosen from the following:

	z	$\cos z$
Sunrise and Sunset	90°50′	−0.01454
Civil Twilight	96°	−0.10453
Nautical Twilight	102°	−0.20791
Astronomical Twilight	108°	−0.30902

Formulas:

(1) $M = 0\overset{\circ}{.}985600t - 3\overset{\circ}{.}289$
(2) $L = M + 1\overset{\circ}{.}916 \sin M + 0\overset{\circ}{.}020 \sin 2M + 282\overset{\circ}{.}634$
(3) $\tan RA = 0.91746 \tan L$
(4) $\sin\delta = 0.39782 \sin L$
(5) $x = \cos H = (\cos z - \sin\delta \sin\phi) / (\cos\delta \cos\phi)$
(6) $T = H + RA - 0\overset{h}{.}065710t - 6\overset{h}{.}622$
(7) $UT = T + \lambda$

Procedure:

1. With an initial value of t, compute M from Eq. (1) and then L from Eq. (2). If a morning phenomenon (sunrise or the beginning of morning twilight) is being computed, construct an initial value of t from the formula
$$t = N + (6^h + \lambda)/24$$
where N is the day of the year (see the calendar on pages A2–A3 or the formulas on page B1) and λ is the observer's longitude expressed in hours. If an evening phenomenon is being computed, use
$$t = N + (18^h + \lambda)/24$$
2. Solve Eq. (3) for RA, noting that RA is in the same quadrant as L. Transform RA to hours for later use in Eq. (6).
3. Solve Eq. (4) for $\sin\delta$ which appears in Eq. (5); $\cos\delta$, which also is required in Eq. (5), should be determined from $\sin\delta$. While $\sin\delta$ may be positive or negative, $\cos\delta$ is always positive.
4. Solve Eq. (5) for H. Since computers and calculators normally give the arccosine in the range 0° – 180°, the correct quadrant for H can be selected according to the following rules:
(a) rising phenomena, $H = 360° - \arccos x$;
(b) setting phenomena, $H = \arccos x$.

In other words, for rising phenomena H must be either in quadrant 3 or 4 (depending on the sign of $\cos H$), whereas H must be either in quadrant 1 or 2 for setting phenomena. Convert H from degrees to hours for use in Eq. (6).

5. Compute T from Eq. (6), recalling that H and RA must be expressed hours. If T is negative or greater than 24^h, it should be converted to the range $0^h - 24^h$ by adding or subtracting multiples of 24^h.
6. Compute UT from Eq. (7), where λ must be expressed in hours. UT is an approximation to the time of sunrise, sunset or twilight, referred to the Greenwich meridian. If UT is greater than 24^h, the phenomenon occurs on the following day, Greenwich time. If UT is negative, the phenomenon occurs on the previous day, Greenwich time.

To ensure that precision is not lost during the computations, t should be carried to four decimal places. Angles should be expressed to three decimals of a degree and, upon conversion, to three decimals of an hour. Five significant digits should be carried for the trigonometric functions.

Under certain conditions Eq. (5) will yield a value of $|\cos H| > 1$, indicating the absence of the phenomenon on that day. At far northern latitudes, for example, there is continuous illumination during certain summer days and continuous darkness during winter days.

Example: Compute the time of sunrise on 25 June at Wayne, New Jersey.

Latitude: 40.°9 North Longitude: 74.°3 West

$\phi = +40.^\circ 9 \qquad \sin\phi = +0.65474 \qquad \cos\phi = +0.75585$

$\lambda = +74.^\circ 3/15 = 4.^h 95$

For sunrise: $z = 90^\circ 50' \qquad \cos z = -0.01454$

$t = 176^d + (6^h + 4.^h 95)/24 = 176.^d 456$

$M = 0.^\circ 985600\,(176.^d 456) - 3.^\circ 289 = 170.^\circ 626$

$L = 170.^\circ 626 + 1.^\circ 916\,(0.16288) + 0.^\circ 020\,(-0.32141) + 282.^\circ 634$

$= 453.^\circ 566 = 93.^\circ 566$

$\tan RA = 0.91746\,(-16.047) = -14.723$

$RA = 93.^\circ 886/15 = 6.^h 259$ Since L is in quadrant 2, so is RA.

$\sin\delta = 0.39782\,(0.99806) = 0.39705$

$\cos\delta = 0.91780$

$x = \cos H = [-0.01454 - (0.39705)(0.65474)] / [(0.91780)(0.75585)]$

$= -0.39570 \qquad \arccos x = 113.^\circ 310$

Since sunrise is being computed, $H = 360^\circ - 113.^\circ 310 = 246.^\circ 690$

$H = 246.^\circ 690/15 = 16.^h 446$

$T = 16.^h 446 + 6.^h 259 - 0.^h 065710\,(176.^d 456) - 6.^h 622 = 4.^h 488$

$UT = 4.^h 488 + 4.^h 95 = 9.^h 44$

Sunrise occurs at $9^h 26^m$ UT $= 5^h 26^m$ EDT

Solar Coordinates

The true geocentric longitude of the Sun (L) can be computed to an accuracy of ±1 minute of arc from the following formulas:

$$M = 358\overset{\circ}{.}476 + 35999\overset{\circ}{.}050T$$
$$\mathcal{L} = 279\overset{\circ}{.}691 + 36000\overset{\circ}{.}769T$$
$$L = \mathcal{L} + (1\overset{\circ}{.}919 - 0\overset{\circ}{.}0048T)\sin M + 0\overset{\circ}{.}020 \sin 2M$$

where $T = (\text{JD} - 2415020.0)\,/\,36525$ and JD is the Julian Date (see page B2).

If we consider the Sun's latitude to be identically zero, the right ascension (RA) and declination (δ) of the Sun can also be computed to ±1 minute of arc from

$$\tan RA = \cos\epsilon \ \tan L$$
$$\sin\delta = \sin\epsilon \ \sin L$$

where ϵ, the obliquity of the ecliptic, can be computed from $\epsilon = 23\overset{\circ}{.}452 - 0\overset{\circ}{.}013T$. The right ascension is always in the same quadrant as the true longitude.

Because the obliquity varies slowly, a single value can be used for an extended period of time. During the last quarter of the twentieth century, $\epsilon = 23\overset{\circ}{.}441$ is sufficiently accurate. Similarly the coefficient of $\sin M$ in the equation for L changes slowly; for the last half of the twentith century a value of $1\overset{\circ}{.}916$ can be safely used.

Although there is no rigorous limit on the time span for which these formulas are valid, their accuracy gradually deteriorates for values of T greater than a couple of centuries.

Equation of Time and Time of Solar Transit

The equation of time (EqT) is the hour angle of the true Sun minus the hour angle of the mean sun. Thus it is the difference: apparent solar (sundial) time minus mean solar (clock) time.

For the current year EqT can be computed to an accuracy of ±0.8 minute from the following formula:

$$(1)\quad EqT = -7\overset{\text{m}}{.}65\sin(0\overset{\circ}{.}9856\,t) + 0\overset{\text{m}}{.}46\cos(0\overset{\circ}{.}9856\,t) - 9\overset{\text{m}}{.}29\sin(1\overset{\circ}{.}9712\,t) - 3\overset{\text{m}}{.}08\cos(1\overset{\circ}{.}9712\,t)$$

where t is the number of days since 0 January, 0^{h} UT.

If higher accuracy is required the following formulas will give EqT to an accuracy of ±2 seconds during the current year:

$$(2)\quad \theta = 9\overset{\circ}{.}574 + 0\overset{\circ}{.}98561\,t + 1\overset{\circ}{.}916\sin(0\overset{\circ}{.}9856\,t - 3\overset{\circ}{.}048) + 0\overset{\circ}{.}020\sin(1\overset{\circ}{.}9712\,t - 6\overset{\circ}{.}096)$$

$$(3)\quad EqT = 38\overset{\text{m}}{.}296 + 3\overset{\text{m}}{.}94244\,t - 4\overset{\text{m}}{.}0\arctan[(\tan\theta)/0.91746]$$

where t is the number of days, and fractions thereof, since 0 January, 0^{h} UT. In Eq. (3) the arctangent should yeild a result in degrees that is in the same quadrant as θ. Near the end of the year θ becomes greater than 360°. When this occurs the arctangent in Eq. (3) should also be greater than 360°.

Eqs. (2) and (3) can be used to compute the time at which the Sun transits the local meridian. First use Eqs. (2) and (3) to compute EqT for $t = N + (12^h + \lambda)/24$, where N is the day of the year (see the calendar on pages A2–A3 or the formulas on pages B1–B2) and λ is the west longitude expressed in hours. Then the local mean time (LMT) of transit is given to an accuracy of ±2 seconds by $LMT = 12^h - EqT$. The universal time of local transit is then obtained from $UT = LMT + \lambda$.

Example: Compute the time of solar transit at longitude 81°38′.0 West on 10 September 1981.

$\lambda = +81^\circ\!.633/15 = +5^h\!.4422 = +5^h 26^m\!.532$

For solar transit: $t = 253^d + (12^h + 5^h\!.4422)/24 = 253^d\!.72676$

$\theta = 9^\circ\!.574 + 0^\circ\!.98561\,(253^d\!.72676) + 1^\circ\!.916\,(-0.9207)$
$\quad + 0^\circ\!.020\,(0.7187) = 257^\circ\!.900$

$EqT = 38^m\!.296 + 3^m\!.94244\,(253^d\!.72676) - 4^m\!.0 \arctan[4.66458/0.91746]$
$\quad = 38^m\!.296 + 1000^m\!.303 - 4^m\!.0(258^\circ\!.873) = +3^m\!.107$

$LMT = 12^h 00^m - 3^m\!.107 = 11^h 56^m\!.893$

$UT = 11^h 56^m\!.893 + 5^h 26^m\!.532 = 17^h 23^m 26^s$ UT

Eastern Daylight Time $= 13^h 23^m 26^s$

Moonrise and Moonset

Times of moonrise and moonset can be computed for specified locations using the following algorithm. Between latitudes 60° North and 60° South, the phenomena can be computed to an accuracy of $\pm 5^m$. Although the algorithm can be used at higher latitudes, its accuracy deteriorates near dates on which the Moon remains above or below the horizon for more than twenty-four hours.

Notation:
- ϕ = latitude of observer (north is positive; south is negative)
- λ = longitude of observer (west is positive; east is negative)
- t_i = *i-th* approximation to universal time of phenomenon, expressed in days from 0 January, 0^h UT
- GHA_i = Moon's GHA at time t_i
- δ_i = Moon's declination at time t_i (north is positive; south is negative)
- τ_i = *i-th* correction to t_0, thus $t_i = t_0 + \tau_i$
- H_i = *i-th* approximation to Moon's LHA at time of rise or set
- ΔH_i = *i-th* approximation to Moon's daily rate of change in GHA

Formulas:

(1) $\Delta H_i = (GHA_i - GHA_0)/\tau_i$ for $i = 0$, let $\Delta H_0 = 347^\circ\!.81$

(2) $x_{i+1} = \cos H_{i+1} = (.00233 - \sin\phi \, \sin\delta_i)/(\cos\phi \, \cos\delta_i)$

(3) $\tau_{i+1} = (H_{i+1} - H_0)/\Delta H_i$

(4) $t_{i+1} = t_0 + \tau_{i+1}$

Procedure:

1. Let $t_0 = N + (12^h + \lambda)/24$, where N is the day of the year (see the calendar on pages A2 – A3 or the formulas on page B1) and λ is the observer's longitude expressed in hours. Set $i = 0$ and begin the following iterative process.
2. For time t_i compute the Moon's GHA and declination to navigational precision ($\pm0\overset{'}{.}1$). Label these quantities GHA_i and δ_i, respectively, where i specifies the iteration number. For $i = 0$, compute $H_0 = GHA_0 - \lambda$.
3. If $i = 0$, let $\Delta H_0 = 347\overset{\circ}{.}81$. Otherwise compute ΔH_i from Eq. (1). If $\Delta H_i < 0$, add $360° / |\tau_i|$ to ΔH_i.
4. Solve Eq. (2) for H_{i+1}. Since computers and calculators normally give the arccosine in the range $0° - 180°$, the correct quadrant for H_{i+1} can be selected according to the following rules:
   (a) moonrise computations, $H_{i+1} = 360° - \arccos x_{i+1}$;
   (b) moonset computations, $H_{i+1} = \arccos x_{i+1}$.
   In other words, near the time of moonrise H_{i+1} must be either in quadrant 3 or 4 (depending on the sign of $\cos H_{i+1}$); near moonset H_{i+1} must be either in quadrant 1 or 2. For latitudes higher than 60° (*i.e.*, $|\phi| > 60°$), the condition $|\cos H_{i+1}| > 1$ can occur, thereby indicating the absence of the phenomenon on that day.
5. Compute τ_{i+1} from Eq. (3). If $|\tau_{i+1}| < 0\overset{d}{.}5$, proceed to Step 6. If $|\tau_{i+1}| > 0\overset{d}{.}5$, the phenomenon being computed occurs on the day prior to the day desired (if τ_{i+1} is negative) or on the day following the day desired (if τ_{i+1} is positive). Normally the phenomenon on the desired day can be obtained by adding to τ_{i+1} (if τ_{i+1} is negative), or subtracting from τ_{i+1} (if τ_{i+1} is positive), $360° / \Delta H_i$. If successful this technique will produce a new value of τ_{i+1} in the required range. However, two conditions may prevent the reduction to $|\tau_{i+1}| < 0\overset{d}{.}5$:
   (a) for low values of i, τ_{i+1} may be a fairly crude approximation to the ultimate value, τ_n;
   (b) each month there is one day (near last quarter) on which there is no moonrise, and another day (near first quarter) on which there is no moonset.

   If $|\tau_{i+1}| \approx 0\overset{d}{.}5$, it is probably worth attempting another iteration to see if $|\tau_{i+2}| < 0\overset{d}{.}5$.
6. Compute t_{i+1} from Eq. (4). If $|t_{i+1} - t_i| < 0\overset{d}{.}01$, t_{i+1} is accurate to $\pm5^m$. Otherwise it is necessary to iterate the solution by setting $i = i + 1$ and executing Steps 2 through 6 again.

Example: Compute moonrise on 12 August 1981 at latitude 60°10′ North and longitude 24°57′ East.

$\phi = +60\overset{\circ}{.}167$ $\quad\quad$ $\sin\phi = +0.86748$ $\quad\quad$ $\cos\phi = +0.49748$

$\lambda = -24\overset{\circ}{.}950/15 = -1\overset{h}{.}663$

From the calendar on pages A2–A3 or the formulas on pages B1–B2, 12 Aug-

is found to be day 224; therefore

$t_0 = 224^d + (12^h - 1\overset{h}{.}663)/24 = 224\overset{d}{.}43069$

$i = 0$: Evaluating the power series on page C17 for t_0,

$GHA_0 = 194\overset{\circ}{.}285$ $\delta_0 = -21\overset{\circ}{.}128$

$H_0 = 194\overset{\circ}{.}285 + 24\overset{\circ}{.}950 = 219\overset{\circ}{.}235$

$\Delta H_0 = 347\overset{\circ}{.}81$

$x_1 = \cos H_1 = [0.00233 - (0.86748)(-0.36045)]/[(0.49748)(0.93278)]$

$= 0.67885$ $\arccos x_1 = 47\overset{\circ}{.}246$

Since moonrise is sought, H_1 is in quadrant 3 or 4:

$H_1 = 312\overset{\circ}{.}754$

$\tau_1 = (312\overset{\circ}{.}754 - 219\overset{\circ}{.}235)/347\overset{\circ}{.}81 = +0\overset{d}{.}26888$

$|\tau_1| < 0\overset{d}{.}5$ as required.

$t_1 = 224\overset{d}{.}43069 + 0\overset{d}{.}26888 = 224\overset{d}{.}69957 =$ 12 August $16^h 47^m$ UT

$i = 1$: Evaluating the power series on page C17 for t_1,

$GHA_1 = 287\overset{\circ}{.}749$ $\delta_1 = -21\overset{\circ}{.}110$

$\Delta H_1 = (287\overset{\circ}{.}749 - 194\overset{\circ}{.}285)/0\overset{d}{.}26888 = 347\overset{\circ}{.}605$

$x_2 = \cos H_2 = [0.00233 - (0.86748)(-0.36016)]/[(0.49748)(0.93289)]$

$= 0.67823$ $\arccos x_2 = 47\overset{\circ}{.}295$

Since moonrise is sought, H_2 is in quadrant 3 or 4:

$H_2 = 312\overset{\circ}{.}705$

$\tau_2 = (312\overset{\circ}{.}705 - 219\overset{\circ}{.}235)/347\overset{\circ}{.}605 = 0\overset{d}{.}26890$

$t_2 = 224\overset{d}{.}43069 + 0\overset{d}{.}26890 = 224\overset{d}{.}69959 =$ 12 August $16^h 47^m$ UT

$|t_2 - t_1| = 0\overset{d}{.}00002 < 0\overset{d}{.}01$

The extremely rapid convergence illustrated in this example occurs frequently but not invariably. Although the first approximation (t_1) will often give adequate precision for most purposes, it is recommended that the solution be iterated and that the convergence criterion ($|t_{i+1} - t_i| < 0\overset{d}{.}01$) be tested.

Polaris (Pole Star)

The following formulas are relevant to observations of Polaris:

(1) $\phi = a - p\cos h + 0.5p\sin p\sin^2 h\tan\phi$

(2) $A\cos\phi = p\sin h + p\sin p\sin h\cos h\tan\phi$

where p is the polar distance of Polaris: $p = 90° -$ declination of Polaris

h is the LHA of Polaris: h = GHA Aries + SHA Polaris + east (−west) longitude of observer

ϕ is the observer's latitude;

A is the azimuth of Polaris;

a is the corrected altitude of Polaris.

Eq. (1) permits the observer's latitude to be determined from an observation of the altitude of Polaris (corrected for refraction, dip, *etc.*). Assumed values of the observer's latitude and longitude can be used for the right side of Eq. (1). Eq. (2) yields the azimuth of Polaris if the observer's position is known. These expressions are accurate only for Polaris, since they depend on p being a small quantity. The SHA and declination of Polaris to be used in these formulas should be referred to the true equator and equinox of date; *i.e.,* the apparent place of Polaris should be computed (see Section E 'Stellar Tables'; Polaris is star number 17).

Equation of Position Line

The following formula can be used to obtain a line of position (LOP) directly from an observation of the altitude of a celestial body:

$$\lambda = \mathrm{GHA} \pm \arccos\left[(\sin a - \sin\phi \sin d) / \cos\phi \cos d\right]$$

where: λ is the computed longitude;
GHA is the GHA of the body for the time of observation;
a is the corrected altitude of the body;
d is the declination of the body for the time of observation;
ϕ is an estimate of the observer's latitude.

North latitudes and west longitudes are positive; south latitudes and east longitudes are negative. Longitudes with absolute values greater than 180° may be encountered. In the above formula, + is used for bodies east of the meridian (rising) and – for bodies west of the meridian (setting).

The formula gives the longitude λ at which the position line crosses the parallel of latitude ϕ. Repeated application of the formula using different values of latitude yields a locus of points all lying in the LOP. Note that no assumed position is necessary, although an estimate of the observer's latitude is helpful in reducing the number of times the formula is applied.

The formula becomes indeterminate at the transit time of a body and for latitudes that the position line does not cross at any point.

Motion of Body and Motion of Observer

During the time interval Δt (*e.g.*, the interval between a sextant observation and the time of a fix), the rotation of the Earth causes a change in the altitude of a celestial body. To permit the use of a common assumed position and LHA Aries for observations made at different times, the following correction can be applied to the observed altitude:

$$\mathrm{MOB} = 15.04\, \Delta t \cos\phi \sin A$$

where MOB is the altitude correction in minutes of arc, Δt is the time difference in minutes, ϕ is the latitude of the observer, and A is the azimuth of the observed body. If the time of the fix is later than the time of observation, MOB should be added to the observed altitude. It should be noted that the formula for MOB is an approximation that becomes unreliable for values of Δt greater than 5 minutes.

The following formula gives the change of altitude of a celestial body due to the motion of the observer in the time interval Δt (*e.g.*, the interval between a sextant observation and the time of a fix). Though this formula is only an approximation to the physical phenomenon, it is the exact mathematical equivalent of advancing or retiring a line of position.

$$\text{MOO} = \frac{v\,\Delta t}{60}\cos(A-C)$$

where MOO is the altitude correction in minutes of arc, Δt is the time difference in minutes, A is the azimuth of the observed body, C is the track/course angle, and v is the ground speed in knots. If the time of the fix is later than the time of observation, MOO should be added to the observed altitude.

Sextant Altitude Corrections

Several corrections must be applied to a sextant altitude (hs) in order to obtain a corrected altitude (Ho). Ho can then be either (a) compared with the computed altitude (Hc) to obtain the altitude difference (Δa); or (b) used in the 'Equation of Position Line' (see p. B12) to obtain directly the location of the LOP for the sight.

The corrections, in the order in which they should be applied, are:

(1) Instrument and/or index correction, IC;
(2) Dip of Horizon, D (marine sextant); or Coriolis correction, Δz (bubble sextant);
(3) Atmospheric refraction, R;
(4) Semidiameter, SD (marine sextant, Sun and Moon observations);
(5) Parallax in altitude, PA (Moon, Venus and Mars observation).

In mathematical notation:

$$\text{Ho} = \text{hs} + \text{IC} + (\text{D or } \Delta z) - \text{R} + \text{SD} + \text{PA}$$

If Venus is observed, an additional correction for the phase of the planet may be necessary. This correction can be made either to the sextant altitude or to the GHA or LHA of Venus.

Descriptions and formulas for D, Δz, R, SD, PA and the phase correction for Venus are given on the following pages.

Dip of Horizon

The dip of the apparent horizon from a horizontal plane is given by

$$\text{D} = -0.97\sqrt{h}$$

where h is the height of eye level of the observer in feet and D is the dip of the horizon in minutes of arc. For observations of a celestial body made with a marine sextant or similar instrument, D should be added to the observed altitude to obtain the corrected altitude. This formula is an approximation; the apparent dip varies with atmospheric conditions.

Coriolis Correction

Any object moving across or above the surface of the rotating Earth is subject to an apparent force tending to push the object to the right in the northern hemisphere and to the left in the southern hemisphere. This Coriolis acceleration manifests itself as a deflection of the apparent vertical by an amount Z:

(1) $$Z = 2.62\, V \sin\phi + 0.146\, V^2 \sin C \tan\phi - 5.25\, VC'$$

where: Z is the deflection in minutes of arc;
V is the speed in hundreds of knots;
ϕ is the latitude;
C is the true track/course angle;
C' is the rate of change of true track/course angle in degrees per minute of time.

The 'Coriolis (Z) Correction' tabulated in the Air Almanac consists of only the first term in Eq. (1). The second term is known as 'Rhumb Line Correction', and the third term is the 'Wander Correction'. Usually only the first term is significant.

Observations of the altitudes of celestial bodies made with bubble sextants or similar artificial horizon instruments must be corrected for the Coriolis effect. The correction Δz, which can be added to the observed (*e.g.*, bubble sextant) altitude, is given approximately by

(2) $$\Delta z = Z \sin(A - C)$$

where: Δz is the altitude correction in minutes of arc;
Z is the deflection of the vertical determined from Eq. (1);
A is the azimuth of observed body;
C is the true track/course angle.

In the northern hemisphere the correction Δz is positive for stars on the right and negative for stars on the left of the aircraft. In the southern hemisphere the correction is negative for stars on the right and positive for stars on the left.

Atmospheric Refraction

The Earth's atmosphere tends to refract light in such a way that celestial bodies appear slightly higher in the sky than they would if there were no atmosphere. The formulas below can be used to determine R, the angle of refraction. R should be subtracted from an observed (*e.g.*, sextant) altitude to obtain the corrected altitude.

(1) $$R = \frac{P}{273 + T}\,[3.430289\,(z - \arcsin\,[0.9986047 \sin\,(0.9967614z)]) - 0.01115929z]$$

(2) $$R = \exp(-h/27000) \tan z = 1/[\exp(h/27000) \tan a]$$

where: R is the refraction correction in minutes of arc;
a is the observed altitude;
z is the observed zenith distance in degrees: $z = 90° - a$;

T is the temperature in degrees Celsius;
P is the atmospheric pressure in millibars;
h is the height of the observer above sea level in feet.

The formulas given above are approximations and are not equivalent to a complete theory of refraction. Eq. (1), which is better suited to surface observations, is accurate to ±0′.1 for altitudes greater than 15°; between altitudes 3° and 15°, errors can reach ±1′.0; for altitudes less than 3°, errors between ±1′ and ±3′ will be encountered. Eq. (2), which is better suited to observations from aircraft, should only be used for altitudes greater than 10°. Above 10° this formula is accurate to ±0′.2.

For surface observations under standard atmospheric conditions, the following Chebyshev series represents refraction for altitudes from 0° to 90° with errors not exceeding ±0′.1.

$$\mathrm{R} = a_0/2 + \sum_{i=1}^{9} a_i T_i(x)$$

where x is related to the observed altitude by $x = 0.442837 \log_e(a + 1.5) - 1$. The coefficients a_i in the series are

$$\begin{array}{ll} a_0 = +28.891741 & a_5 = +0.340097 \\ a_1 = -20.516167 & a_6 = -0.024576 \\ a_2 = +\ 7.291562 & a_7 = -0.050041 \\ a_3 = -\ 0.813492 & a_8 = +0.023252 \\ a_4 = -\ 0.690042 & a_9 = -0.009406 \end{array}$$

The sum of these coefficients is +14.442928.

For a given value of the altitude a, compute x. Then the series can be evaluated as follows:

$$\begin{array}{lll} \text{let} & b_{10} = b_{11} = 0, & \\ \text{compute} & b_i = 2x b_{i+1} - b_{i+2} + a_i, & \text{for } i = 9, 8, \ldots, 0, \\ \text{then} & \mathrm{R} = (b_0 - b_2)/2. & \end{array}$$

Example: A star is observed from the Earth's surface under standard atmospheric conditions to be at altitude 10°.0. Use the Chebyshev series to compute the refraction correction.

$a = 10°.0 \qquad x = 0.442837 \log_e(10.0 + 1.5) - 1 = +0.081562$

$$\begin{array}{lrrrrrrr} b_{10} = b_{11} = 0 & & & & & & & \\ b_9 & = & 0.0 & - 0.0 & - & 0.009406 & = & -\ 0.009406 \\ b_8 & = & -0.001534 & - 0.0 & + & 0.023252 & = & +\ 0.021718 \\ b_7 & = & +0.003543 & + 0.009406 & - & 0.050041 & = & -\ 0.037092 \\ b_6 & = & -0.006051 & - 0.021718 & - & 0.024576 & = & -\ 0.052345 \\ b_5 & = & -0.008539 & + 0.037092 & + & 0.340097 & = & +\ 0.368650 \\ b_4 & = & +0.060136 & + 0.052345 & - & 0.690042 & = & -\ 0.577561 \\ b_3 & = & -0.094214 & - 0.368650 & - & 0.813492 & = & -\ 1.276356 \\ b_2 & = & -0.208204 & + 0.577561 & + & 7.291562 & = & +\ 7.660919 \\ b_1 & = & +1.249680 & + 1.276356 & - & 20.516167 & = & -17.990131 \\ b_0 & = & -2.934622 & - 7.660919 & + & 28.891741 & = & +18.296200 \end{array}$$

$$\mathrm{R} = (18.296200 - 7.660919)/2 = 5'.3$$

Semidiameter of the Sun and Planets

The semidiameters of the Sun and planets can be computed from

$$SD = S/d = S\pi/8.794$$

where: SD is the semidiameter in seconds of arc;
S is the semidiameter at unit distance (1 AU) in seconds of arc;
d is the geocentric distance in AU;
π is the horizontal parallax in seconds of arc.

The following values of S should be used:

Sun	959″63	Jupiter	98″47
Mercury	3.34	Saturn	83.33
Venus	8.41	Uranus	34.28
Mars	4.68	Neptune	36.56

These values apply to the equatorial dimensions of the bodies and do not include any adjustments for irradiation.

Semidiameter of the Moon

The geocentric semidiameter of the Moon can be computed from

(1) $$SD = 56204.92/d = 0.272476\,\pi$$

where SD is the geocentric semidiameter in seconds of arc, d is the geocentric distance of the Moon in units of the Earth's equatorial radius, and π is the horizontal parallax of the Moon in seconds of arc.

Since observations are made from the Earth's surface rather than from its center, the observed, topocentric semidiameter is slightly greater than the geocentric semidiameter. For navigation and certain other purposes the *augmented semidiameter* of the Moon should be used:

(2) $$SD_{aug} = SD[1 + (\sin a)/d]$$

where SD_{aug} is the augmented semidiameter in seconds of arc, a is the altitude of the Moon (for navigational purposes a = Ho, but hs or Hc can be used instead with negligible error), d is the geocentric distance of the Moon in units of the Earth's equatorial radius, and SD is the geocentric semidiameter computed from Eq.(1). For navigational purposes a constant value of d = 60.27 can be used to sufficient accuracy. The increase in the Moon's semidiameter due to augmentation is zero when the Moon is on the horizon and is about 0′3 when the Moon is at the zenith.

Parallax in Altitude

The finite size of the Earth causes a parallactic shift in the apparent positions of nearby celestial objects. The resulting parallax in altitude can be computed from

$$\sin PA = \sin\pi \cos a$$

where PA is the parallax in altitude, π is the horizontal parallax, and a is the observed altitude. When the horizontal parallax of a body is not available, it can be computed from the relation $\pi = 8\overset{''}{.}794/d$, where d is the geocentric distance of the body in astronomical units. Except for the Moon, parallax in altitude does not exceed $1'$. Since parallax tends to decrease the apparent altitude of a body, the quantity PA should be added to an observed (*e.g.*, sextant) altitude in order to obtain the corrected altitude. To a reasonable approximation, PA can also be computed from

$$\mathrm{PA} = \pi \cos a$$

Correction for the Phase of Venus

When the altitude of Venus is observed with a small instrument, a correction to the observed altitude is required to account for the fact that the center of light, rather than the center of the disk, is observed. This correction has the form $-k \cos\theta$, where k is a correction factor (given below) and θ is the angle on the celestial sphere, at the position of Venus, between the observer's vertical and the direction of the Sun. The correction, which should be added to the observed (*e.g.*, sextant) altitude, is positive when the Sun is lower than Venus, zero when they have the same altitude, and negative when the Sun is higher.

In sight reduction this effect can be approximately taken into account by correcting the GHA (or LHA) of Venus rather than correcting the observed altitude. Simply add k to the GHA (or LHA) of Venus when Venus is east of the Sun (*i.e.*, when Venus is an evening planet), and subtract k from the GHA (or LHA) when Venus is west of the Sun (morning planet). The correction should not be applied in this way near the time of superior or inferior conjunction.

Venus is at superior conjunction on 7 April 1981. Prior to this date Venus is in the morning sky. Following superior conjunction Venus is in the evening sky.

The values of k for 1981 are

		k
Jan.	1	
		$0\overset{'}{.}0$
Sept.	30	
		0.1
Nov.	21	
		0.2
Dec.	15	
		0.3
Dec.	30	
		0.4
Dec.	31	

Section C: NAVIGATIONAL TABLES

POWER SERIES APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1981

DAYS 1 THRU 32 JD 2444605.5 TO 2444637.5 DATES JAN 1 THRU FEB 1

A = 16.0 B = -1.06250000 W = 1

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
TERM	DEG	DEG	DEG	DEG
0	6236.3275	6297.4958	-20.7985	0.2717
1	5775.7686	5758.6729	3.1239	0.0
2	0.0001	0.3807	0.8436	0.0
3	0.0043	0.0353	-0.0573	0.0
4	-0.0001	-0.0162	-0.0055	0.0
5	-0.0027	0.0046	-0.0022	0.0
SUMS	12012.0977	12056.5731	-16.8960	0.2717

DAYS 32 THRU 63 JD 2444636.5 TO 2444668.5 DATES FEB 1 THRU MAR 4

A = 16.0 B = -3.00000000 W = 32

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
TERM	DEG	DEG	DEG	DEG
0	5906.8826	5936.4775	-12.0860	0.2699
1	5775.7697	5760.2830	5.5861	0.0007
2	0.0001	0.3787	0.4091	0.0004
3	0.0012	-0.0462	-0.0816	-0.0031
4	-0.0003	-0.0090	0.0020	0.0006
5	-0.0007	0.0045	0.0020	0.0015
SUMS	11682.6526	11697.0885	-6.1684	0.2700

DAYS 60 THRU 91 JD 2444664.5 TO 2444696.5 DATES MAR 1 THRU APR 1

A = 16.0 B = -4.75000000 W = 60

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
TERM	DEG	DEG	DEG	DEG
0	5934.4809	5937.8660	-1.4663	0.2681
1	5775.7709	5761.1519	6.3245	0.0
2	-0.0032	0.1134	0.0170	0.0041
3	-0.0034	-0.0568	-0.0739	-0.0022
4	0.0028	-0.0050	0.0032	-0.0039
5	0.0030	-0.0021	0.0032	0.0004
SUMS	11710.2510	11699.0674	4.8077	0.2665

DAYS 91 THRU 122 JD 2444695.5 TO 2444727.5 DATES APR 1 THRU MAY 2

A = 16.0 B = -6.68750000 W = 91

	ARIES GHA	SUN GHA	SUN DEC	SUN S D
TERM	DEG	DEG	DEG	DEG
0	5965.0361	5940.0817	10.3663	0.2665
1	5775.7707	5760.9393	5.6404	-0.0019
2	-0.0036	-0.1986	-0.3668	-0.0026
3	-0.0026	-0.0495	-0.0595	0.0016
4	0.0031	0.0039	0.0025	0.0020
5	0.0025	0.0033	-0.0014	-0.0005
SUMS	11740.8062	11700.7801	15.5815	0.2651

DAYS 1 THRU 32 JD 2444605.5 TO 2444637.5 DATES JAN 1 THRU FEB 1

A = 16.0 B = -1.06250000 W = 1

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	6318.5505	-23.0709	6280.0969	-17.8524	6406.3267	-2.8092	6406.3848	-1.6396
1	5753.9989	0.3844	5763.0703	3.6623	5775.3794	-0.0892	5775.6954	0.0501
2	0.0561	1.5113	0.2311	0.4078	0.3710	0.1582	0.2127	0.0892
3	0.1690	-0.0148	0.0064	-0.0334	0.0031	0.0073	0.0008	0.0025
4	-0.0041	-0.0254	-0.0047	-0.0022	-0.0038	-0.0004	-0.0013	0.0002
5	-0.0072	0.0071	0.0004	-0.0004	0.0034	-0.0045	-0.0008	-0.0025
SUMS	12072.7632	-21.2083	12043.4004	-13.8183	12182.0798	-2.7378	12182.2916	-1.5001

DAYS 32 THRU 63 JD 2444636.5 TO 2444668.5 DATES FEB 1 THRU MAR 4

A = 16.0 B = -3.00000000 W = 32

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5948.1673	-17.0195	5926.9034	-9.5046	6077.5184	-2.3927	6077.5682	-1.2227
1	5755.6680	5.5390	5763.9308	4.8042	5776.7926	0.5011	5776.4675	0.3606
2	0.6280	1.0238	0.1933	0.1791	0.3304	0.1329	0.1716	0.0643
3	-0.0055	-0.1320	-0.0224	-0.0372	-0.0193	-0.0110	-0.0196	0.0006
4	-0.0263	-0.0054	-0.0058	-0.0005	-0.0072	-0.0021	-0.0035	-0.0007
5	0.0016	0.0005	0.0028	-0.0027	-0.0045	0.0001	0.0028	-0.0071
SUMS	11704.4331	-10.5936	11691.0021	-4.5617	11854.6104	-1.7717	11854.1870	-0.8050

DAYS 60 THRU 91 JD 2444664.5 TO 2444696.5 DATES MAR 1 THRU APR 1

A = 16.0 B = -4.75000000 W = 60

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5942.2815	-4.9350	5934.2457	-0.7591	6107.7303	-1.1913	6106.8021	-0.4388
1	5757.3915	7.8385	5764.3991	5.0711	5777.6010	0.8111	5776.8764	0.5014
2	0.2661	0.2834	0.0780	-0.0212	0.1060	0.0298	0.0566	0.0085
3	-0.1162	-0.1401	-0.0340	-0.0268	-0.0547	-0.0255	-0.0261	-0.0108
4	-0.0067	0.0052	-0.0038	0.0013	-0.0026	0.0016	-0.0017	0.0020
5	0.0040	0.0016	0.0065	-0.0066	0.0008	0.0011	0.0006	-0.0002
SUMS	11699.8202	3.0536	11698.6915	4.2587	11885.3808	-0.3732	11883.7079	0.0621

DAYS 91 THRU 122 JD 2444695.5 TO 2444727.5 DATES APR 1 THRU MAY 2

A = 16.0 B = -6.68750000 W = 91

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5937.3692	10.3307	5942.8726	8.7435	6141.8185	0.3203	6139.5163	0.4927
1	5757.1104	7.4035	5764.4336	4.6134	5777.3811	0.6612	5776.7966	0.4176
2	-0.3930	-0.5143	-0.0486	-0.2124	-0.2090	-0.1035	-0.0918	-0.0502
3	-0.1036	-0.1363	-0.0211	-0.0306	-0.0467	-0.0182	-0.0254	-0.0072
4	0.0098	-0.0002	0.0021	0.0025	0.0056	0.0033	-0.0003	-0.0014
5	0.0069	-0.0034	0.0016	0.0002	0.0029	0.0007	0.0028	-0.0004
SUMS	11693.9997	17.0800	11707.2402	13.1166	11918.9524	0.8638	11916.1982	0.8511

POWER SERIES APPROXIMATION OF NAUTICAL ALMANAC DATA FOR YEAR 1981

DAYS 121 THRU 152 JD 2444725.5 TO 2444757.5 DATES MAY 1 THRU JUNE 1

A = 16.0 B = -8.56250000 W = 121

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	5994.6050	5940.9227	19.2560	0.2642
1	5775.7720	5759.9052	3.6306	-0.0033
2	0.0	-0.2927	-0.6941	0.0
3	-0.0028	0.0052	-0.0461	0.0061
4	0.0	0.0043	0.0011	0.0
5	0.0013	0.0021	-0.0031	-0.0037
SUMS	11770.3755	11700.5468	22.1444	0.2633

DAYS 152 THRU 183 JD 2444756.5 TO 2444788.5 DATES JUNE 1 THRU JULY 2

A = 16.0 B = -10.50000000 W = 152

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	6025.1600	5939.8258	23.3709	0.2633
1	5775.7718	5759.1452	0.4940	0.0
2	-0.0007	-0.0383	-0.8792	0.0
3	-0.0033	0.0502	-0.0057	0.0
4	0.0006	0.0003	0.0061	0.0
5	0.0018	0.0073	-0.0001	0.0
SUMS	11800.9302	11698.9905	22.9860	0.2633

DAYS 182 THRU 213 JD 2444786.5 TO 2444818.5 DATES JULY 1 THRU AUG 1

A = 16.0 B = -12.37500000 W = 182

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	6054.7292	5938.4961	21.2518	0.2633
1	5775.7687	5759.6532	-2.6831	0.0
2	0.0	0.2773	-0.7689	0.0
3	0.0041	0.0233	0.0373	0.0
4	0.0	-0.0077	0.0045	0.0
5	-0.0025	0.0028	0.0031	0.0
SUMS	11830.4995	11698.4450	17.8447	0.2633

DAYS 213 THRU 244 JD 2444817.5 TO 2444849.5 DATES AUG 1 THRU SEPT 1

A = 16.0 B = -14.31250000 W = 213

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	6085.2842	5938.9735	13.5217	0.2633
1	5775.7687	5760.8436	-5.0933	-0.0007
2	0.0	0.2692	-0.4552	0.0004
3	0.0041	-0.0351	0.0649	0.0031
4	0.0	-0.0027	-0.0015	0.0006
5	-0.0025	0.0011	-0.0044	-0.0015
SUMS	11861.0545	11700.0496	8.0322	0.2652

DAYS 121 THRU 152 JD 2444725.5 TO 2444757.5 DATES MAY 1 THRU JUNE 1

A = 16.0 B = -8.56250000 W = 121

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5930.1253	21.4839	5950.9229	16.4663	5813.4487	1.1107	5810.5542	1.0465
1	5755.0735	4.0121	5764.1255	3.5336	5776.2689	0.1468	5776.2559	0.1528
2	-0.5284	-1.2718	-0.0990	-0.3558	-0.3490	-0.1556	-0.1834	-0.0831
3	0.0693	-0.1157	-0.0017	-0.0193	-0.0025	0.0050	-0.0134	-0.0047
4	0.0251	0.0119	0.0022	0.0005	0.0040	0.0015	0.0028	-0.0006
5	-0.0006	0.0058	0.0004	-0.0018	-0.0038	-0.0050	0.0041	0.0012
SUMS	11684.7642	24.1262	11714.9503	19.6235	11589.3663	1.1034	11586.6202	1.1121

DAYS 152 THRU 183 JD 2444756.5 TO 2444788.5 DATES JUNE 1 THRU JULY 2

A = 16.0 B = -10.50000000 W = 152

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5919.4456	23.9030	5958.5776	21.8391	5843.6566	0.8227	5841.3255	1.0148
1	5754.4857	-1.6620	5763.8194	1.9534	5774.9300	-0.4333	5775.5003	-0.1852
2	0.3217	-1.4916	-0.0407	-0.4447	-0.3186	-0.1389	-0.1971	-0.0826
3	0.1443	0.0494	0.0125	-0.0086	0.0158	0.0057	0.0068	0.0061
4	-0.0168	0.0192	0.0025	0.0003	-0.0021	0.0023	0.0028	-0.0001
5	0.0029	-0.0018	0.0037	0.0001	-0.0015	0.0002	-0.0028	-0.0027
SUMS	11674.3834	20.8162	11722.3750	23.3396	11618.2802	0.2587	11616.6355	0.7503

DAYS 182 THRU 213 JD 2444786.5 TO 2444818.5 DATES JULY 1 THRU AUG 1

A = 16.0 B = -12.37500000 W = 182

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5910.9716	16.0864	5965.7442	23.9035	5870.6140	-0.4297	5869.7348	0.3944
1	5756.7121	-6.2897	5763.9179	0.2503	5773.8752	-0.8756	5774.8251	-0.4670
2	0.6795	-0.8938	0.0984	-0.4482	-0.2369	-0.0972	-0.1579	-0.0661
3	-0.0445	0.1368	0.0267	-0.0017	0.0170	0.0015	0.0083	0.0048
4	-0.0210	0.0021	0.0007	0.0024	-0.0014	0.0004	-0.0017	0.0015
5	0.0073	-0.0022	-0.0015	0.0073	-0.0010	0.0055	0.0001	0.0002
SUMS	11668.3050	9.0396	11729.7864	23.7136	11644.2669	-1.3951	11644.4087	-0.1322

DAYS 213 THRU 244 JD 2444817.5 TO 2444849.5 DATES AUG 1 THRU SEPT 1

A = 16.0 B = -14.31250000 W = 213

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5906.6638	1.5337	5973.8911	22.7848	5896.7167	-2.4381	5897.9224	-0.7193
1	5758.5180	-8.2303	5764.5782	-1.3442	5773.1274	-1.1712	5774.3054	-0.6662
2	0.1847	-0.1164	0.2248	-0.3606	-0.1514	-0.0542	-0.1054	-0.0379
3	-0.1132	0.1302	0.0115	0.0133	0.0057	0.0107	0.0135	0.0037
4	-0.0032	-0.0021	-0.0001	-0.0009	-0.0007	-0.0008	0.0002	0.0
5	0.0013	-0.0010	0.0016	0.0049	0.0054	-0.0025	-0.0025	0.0015
SUMS	11665.2514	-6.6859	11738.7071	21.0973	11669.7031	-3.6561	11672.1336	-1.4182

DAYS 244 THRU 275 JD 2444848.5 TO 2444880.5 DATES SEPT 1 THRU OCT 2

A = 16.0 B = -16.25000000 W = 244

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	6115.8392	5941.3392	2.3788	0.2651
1	5775.7687	5761.4270	-6.1795	0.0019
2	0.0	-0.0051	-0.1033	0.0026
3	0.0041	-0.0603	0.0596	-0.0016
4	0.0	0.0036	0.0021	-0.0020
5	-0.0025	-0.0005	0.0024	0.0005
SUMS	11891.6095	11702.7039	-3.8399	0.2665

DAYS 274 THRU 305 JD 2444878.5 TO 2444910.5 DATES OCT 1 THRU NOV 1

A = 16.0 B = -18.12500000 W = 274

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	6145.4085	5943.6340	-9.1377	0.2675
1	5775.7702	5760.8308	-5.8647	0.0033
2	0.0006	-0.3208	0.2773	0.0
3	0.0009	-0.0645	0.0726	-0.0061
4	-0.0008	0.0087	0.0027	0.0
5	-0.0009	0.0107	-0.0007	0.0037
SUMS	11921.1785	11704.0989	-14.6505	0.2684

DAYS 305 THRU 336 JD 2444909.5 TO 2444941.5 DATES NOV 1 THRU DEC 2

A = 16.0 B = -20.06250000 W = 305

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	5815.9638	5943.7756	-18.9082	0.2701
1	5775.7697	5759.2310	-3.9340	-0.0007
2	-0.0003	-0.4518	0.7185	-0.0004
3	0.0024	0.0196	0.0712	0.0031
4	-0.0001	0.0155	-0.0037	-0.0006
5	-0.0020	-0.0034	0.0002	-0.0015
SUMS	11591.7335	11702.5865	-22.0560	0.2700

DAYS 334 THRU 365 JD 2444938.5 TO 2444970.5 DATES NOV 30 THRU DEC 31

A = 16.0 B = -21.87500000 W = 334

TERM	ARIES GHA DEG	SUN GHA DEG	SUN DEC DEG	SUN S D DEG
0	5844.5474	5941.1443	-23.3020	0.2718
1	5775.7699	5758.0672	-0.7428	-0.0004
2	-0.0014	-0.1297	0.9929	-0.0027
3	0.0023	0.0797	0.0154	0.0046
4	0.0012	0.0069	-0.0105	0.0017
5	-0.0016	0.0060	0.0012	-0.0036
SUMS	11620.3178	11699.1744	-23.0458	0.2714

DAYS 244 THRU 275 JD 2444848.5 TO 2444880.5 DATES SEPT 1 THRU OCT 2

A = 16.0 B = -16.25000000 W = 244

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5903.6929	-13.9257	5983.6987	18.9746	5921.6712	-4.8613	5925.3201	-2.1164
1	5758.0563	-7.2462	5765.5756	-2.5009	5772.6838	-1.3076	5774.0136	-0.7562
2	-0.3704	0.6288	0.2673	-0.2276	-0.0765	-0.0168	-0.0426	-0.0102
3	-0.0691	0.1260	0.0029	0.0255	0.0085	0.0136	0.0155	-0.0010
4	0.0143	-0.0005	0.0032	-0.0018	-0.0011	0.0013	-0.0013	0.0003
5	0.0079	0.0024	-0.0009	-0.0016	0.0027	-0.0058	-0.0036	0.0041
SUMS	11661.3319	-20.4152	11749.5468	16.2682	11694.2886	-6.1766	11699.3017	-2.8794

DAYS 274 THRU 305 JD 2444878.5 TO 2444910.5 DATES OCT 1 THRU NOV 1

A = 16.0 B = -18.12500000 W = 274

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5898.6175	-24.4712	5995.1144	13.6400	5945.2601	-7.3245	5951.5153	-3.5379
1	5756.6627	-3.5838	5766.5968	-3.1073	5772.5209	-1.2988	5773.9665	-0.7395
2	-0.1615	1.2781	0.2623	-0.0909	-0.0096	0.0206	0.0191	0.0210
3	0.1513	0.0671	-0.0083	0.0327	0.0167	0.0057	0.0089	0.0040
4	0.0334	-0.0193	0.0027	-0.0020	0.0025	-0.0013	-0.0003	-0.0016
5	0.0008	0.0035	0.0056	-0.0055	-0.0024	-0.0004	0.0023	0.0004
SUMS	11655.3042	-26.7256	11761.9735	10.4670	11717.7882	-8.5987	11725.5118	-4.2536

DAYS 305 THRU 336 JD 2444909.5 TO 2444941.5 DATES NOV 1 THRU DEC 2

A = 16.0 B = -20.06250000 W = 305

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5893.1267	-26.3842	6008.8902	7.4502	5969.5918	-9.7270	5978.7314	-4.8634
1	5758.6913	1.5610	5767.6261	-3.1951	5772.6491	-1.1578	5774.1741	-0.6110
2	1.3722	1.1888	0.2745	0.0448	0.0751	0.0566	0.0919	0.0437
3	0.3212	-0.1209	0.0189	0.0198	0.0145	0.0063	0.0155	0.0076
4	0.0164	-0.0257	0.0037	-0.0005	0.0019	-0.0029	-0.0019	0.0029
5	0.0045	0.0040	-0.0063	0.0021	0.0017	-0.0001	-0.0022	-0.0029
SUMS	11653.5323	-23.7770	11776.8071	4.3213	11742.3341	-10.8249	11753.0088	-5.4231

DAYS 334 THRU 365 JD 2444938.5 TO 2444970.5 DATES NOV 30 THRU DEC 31

A = 16.0 B = -21.87500000 W = 334

TERM	VENUS GHA DEG	VENUS DEC DEG	MARS GHA DEG	MARS DEC DEG	JUPITER GHA DEG	JUPITER DEC DEG	SATURN GHA DEG	SATURN DEC DEG
0	5897.4733	-20.5977	6023.7091	1.9456	5992.8710	-11.6150	6004.7935	-5.7894
1	5767.5480	4.1805	5768.7831	-2.7975	5773.0972	-0.9102	5774.6246	-0.3963
2	3.7739	0.1277	0.3765	0.1741	0.1750	0.0814	0.1567	0.0705
3	0.5904	-0.2581	0.0310	0.0217	0.0168	0.0071	0.0087	0.0023
4	0.0289	-0.0157	0.0095	0.0016	-0.0005	0.0011	-0.0003	-0.0003
5	-0.0125	-0.0031	0.0047	0.0022	0.0026	-0.0013	0.0018	0.0014
SUMS	11669.4020	-16.5664	11792.9139	-0.6523	11766.1621	-12.4369	11779.5850	-6.1118

DAYS 1 THRU 6 JD 2444605.5 TO 2444611.5 DATES JAN 1 THRU JAN 6

A = 3.0 B = -1.33333333 W = 1

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1647.6716	-18.5309	0.9225	0.2513
1	1044.0868	-5.5860	0.0265	0.0072
2	-2.4186	3.8024	0.0042	0.0011
3	0.2497	0.7333	-0.0082	-0.0022
4	0.2842	-0.0828	0.0007	0.0002
5	-0.0035	-0.0559	0.0042	0.0011
SUMS	2689.8702	-19.7199	0.9499	0.2587

DAYS 7 THRU 12 JD 2444611.5 TO 2444617.5 DATES JAN 7 THRU JAN 12

A = 3.0 B = -3.33333333 W = 7

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1211.4859	-11.5851	0.9725	0.2650
1	1042.5943	11.9871	0.0177	0.0048
2	1.0886	2.9817	-0.0078	-0.0021
3	-0.2030	-1.0241	0.0004	0.0001
4	-0.2771	-0.1119	0.0026	0.0007
5	0.0376	0.0409	-0.0002	-0.0001
SUMS	2254.7263	2.2886	0.9852	0.2684

DAYS 13 THRU 18 JD 2444617.5 TO 2444623.5 DATES JAN 13 THRU JAN 18

A = 3.0 B = -5.33333333 W = 13

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1136.6016	15.2449	0.9876	0.2691
1	1040.0437	10.0583	-0.0043	-0.0012
2	-1.9522	-4.0967	-0.0048	-0.0013
3	0.2585	-1.0986	-0.0015	-0.0004
4	0.3976	0.1741	-0.0034	-0.0009
5	0.0165	0.0745	0.0007	0.0002
SUMS	2175.3657	20.3565	0.9743	0.2655

DAYS 19 THRU 24 JD 2444623.5 TO 2444629.5 DATES JAN 19 THRU JAN 24

A = 3.0 B = -7.33333333 W = 19

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1056.0892	15.0356	0.9454	0.2576
1	1043.6203	-9.3936	-0.0340	-0.0093
2	3.1813	-3.0421	-0.0042	-0.0011
3	-0.1087	1.0924	0.0073	0.0020
4	-0.3381	-0.0026	0.0040	0.0011
5	0.0561	-0.0639	-0.0029	-0.0008
SUMS	2102.5001	3.6258	0.9156	0.2495

DAYS 25 THRU 30 JD 2444629.5 TO 2444635.5 DATES JAN 25 THRU JAN 30

A = 3.0 B = -9.33333333 W = 25

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1351.6937	-8.5554	0.9034	0.2461
1	1048.9543	-11.2743	0.0028	0.0008
2	-1.0501	1.4741	0.0130	0.0035
3	-0.7641	0.5720	-0.0056	-0.0015
4	0.0776	0.0215	0.0004	0.0001
5	0.0305	0.0156	0.0041	0.0011
SUMS	2398.9419	-17.7465	0.9181	0.2501

DAYS 31 THRU 36 JD 2444635.5 TO 2444641.5 DATES JAN 31 THRU FEB 5

A = 3.0 B = -11.33333333 W = 31

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1281.6456	-20.0729	0.9501	0.2589
1	1040.8921	2.3668	0.0360	0.0098
2	-1.0439	5.0634	0.0003	0.0001
3	0.9292	0.1263	-0.0036	-0.0010
4	0.0570	-0.2789	-0.0009	-0.0002
5	-0.1046	-0.0340	-0.0005	-0.0001
SUMS	2322.3754	-12.8293	0.9814	0.2675

DAYS 37 THRU 42 JD 2444641.5 TO 2444647.5 DATES FEB 6 THRU FEB 11

A = 3.0 B = -13.33333333 W = 37

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1204.5233	1.0926	0.9919	0.2703
1	1042.6303	14.9401	-0.0030	-0.0008
2	-0.0770	-0.3137	-0.0073	-0.0020
3	-0.6590	-1.3296	0.0093	0.0025
4	-0.0216	0.0293	-0.0017	-0.0005
5	0.0787	0.0265	-0.0055	-0.0015
SUMS	2246.4747	14.4452	0.9837	0.2680

DAYS 43 THRU 48 JD 2444647.5 TO 2444653.5 DATES FEB 12 THRU FEB 17

A = 3.0 B = -15.33333333 W = 43

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1126.2626	20.3369	0.9661	0.2632
1	1039.4629	0.7095	-0.0212	-0.0058
2	0.6211	-5.3868	-0.0021	-0.0006
3	1.0773	0.1167	0.0008	0.0002
4	0.0059	0.3094	-0.0008	-0.0002
5	-0.1261	-0.0124	0.0	0.0
SUMS	2167.3037	16.0733	0.9428	0.2568

DAYS 49 THRU 54 JD 2444653.5 TO 2444659.5 DATES FEB 18 THRU FEB 23

A = 3.0 B = -17.33333333 W = 49

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1413.2004	5.0715	0.9184	0.2502
1	1048.0504	-12.4995	-0.0237	-0.0064
2	1.5973	-0.6216	0.0039	0.0011
3	-0.6751	0.8075	0.0100	0.0027
4	-0.0804	-0.0746	0.0009	0.0002
5	0.0381	-0.0056	-0.0064	-0.0017
SUMS	2462.1307	-7.3223	0.9031	0.2461

DAYS 55 THRU 60 JD 2444659.5 TO 2444665.5 DATES FEB 24 THRU MAR 1

A = 3.0 B = -19.33333333 W = 55

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1349.9921	-17.0081	0.9103	0.2480
1	1046.0938	-7.1427	0.0178	0.0049
2	-2.1933	3.1678	0.0131	0.0036
3	-0.2729	0.6421	0.0027	0.0007
4	0.1892	0.0033	-0.0009	-0.0002
5	0.0365	-0.0153	-0.0014	-0.0004
SUMS	2393.8454	-20.3529	0.9416	0.2566

DAYS 61 THRU 66 JD 2444665.5 TO 2444671.5 DATES MAR 2 THRU MAR 7

A = 3.0 B = -21.33333333 W = 61

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1274.7508	-14.3653	0.9833	0.2679
1	1040.6779	10.7208	0.0372	0.0101
2	0.3054	4.1872	-0.0080	-0.0022
3	0.3394	-0.8634	-0.0045	-0.0012
4	-0.2184	-0.2894	-0.0012	-0.0003
5	-0.0230	0.0290	-0.0001	0.0
SUMS	2315.8321	-0.5811	1.0067	0.2743

DAYS 67 THRU 72 JD 2444671.5 TO 2444677.5 DATES MAR 8 THRU MAR 13

A = 3.0 B = -23.33333333 W = 67

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1196.6810	13.6365	0.9967	0.2716
1	1040.0301	11.5015	-0.0243	-0.0066
2	-0.9491	-3.9796	-0.0087	-0.0024
3	0.0988	-1.0585	0.0051	0.0014
4	0.2546	0.2391	-0.0013	-0.0003
5	0.0241	0.0326	-0.0008	-0.0002
SUMS	2236.1395	20.3716	0.9667	0.2635

DAYS 73 THRU 78 JD 2444677.5 TO 2444683.5 DATES MAR 14 THRU MAR 19

A = 3.0 B = -25.33333333 W = 73

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1117.3860	16.8567	0.9383	0.2557
1	1043.5386	-7.8851	-0.0259	-0.0070
2	2.6027	-3.5840	0.0051	0.0014
3	0.0418	0.8903	0.0012	0.0003
4	-0.2488	0.0600	-0.0015	-0.0004
5	0.0211	-0.0445	-0.0010	-0.0003
SUMS	2163.3414	6.2934	0.9162	0.2497

DAYS 79 THRU 84 JD 2444683.5 TO 2444689.5 DATES MAR 20 THRU MAR 25

A = 3.0 B = -27.33333333 W = 79

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1412.2284	-6.2329	0.9022	0.2458
1	1049.1319	-11.9969	-0.0077	-0.0021
2	-0.3977	1.1973	0.0078	0.0021
3	-0.6155	0.6341	0.0027	0.0007
4	0.0463	-0.0258	-0.0001	0.0
5	0.0182	0.0074	-0.0013	-0.0004
SUMS	2460.4116	-16.4168	0.9036	0.2461

DAYS 85 THRU 90 JD 2444689.5 TO 2444695.5 DATES MAR 26 THRU MAR 31

A = 3.0 B = -29.33333333 W = 85

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1345.2873	-20.5989	0.9267	0.2525
1	1043.0794	-0.0732	0.0342	0.0093
2	-1.5306	4.5671	0.0115	0.0031
3	0.4141	0.3580	0.0026	0.0007
4	0.1016	-0.1353	-0.0011	-0.0003
5	-0.0473	-0.0353	-0.0038	-0.0010
SUMS	2387.3045	-15.9176	0.9701	0.2643

DAYS 91 THRU 96 JD 2444695.5 TO 2444701.5 DATES APR 1 THRU APR 6

A = 3.0 B = -31.33333333 W = 91

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1268.5624	-2.8437	1.0108	0.2754
1	1040.9666	15.6386	0.0276	0.0075
2	-0.5897	1.2032	-0.0168	-0.0046
3	-0.4045	-1.5794	-0.0066	-0.0018
4	-0.0396	-0.1587	-0.0014	-0.0004
5	0.0682	0.0602	0.0019	0.0005
SUMS	2308.5634	12.3202	1.0155	0.2766

DAYS 97 THRU 102 JD 2444701.5 TO 2444707.5 DATES APR 7 THRU APR 12

A = 3.0 B = -33.33333333 W = 97

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1186.6168	20.4206	0.9824	0.2677
1	1038.2062	2.5329	-0.0405	-0.0110
2	1.2104	-5.8041	-0.0027	-0.0007
3	1.1170	0.1702	0.0042	0.0011
4	-0.0665	0.3556	-0.0003	-0.0001
5	-0.1258	-0.0519	0.0002	0.0001
SUMS	2226.9581	17.6233	0.9433	0.2571

DAYS 103 THRU 108 JD 2444707.5 TO 2444713.5 DATES APR 13 THRU APR 18

A = 3.0 B = -35.33333333 W = 103

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1112.8062	7.3889	0.9155	0.2495
1	1048.1049	-12.1875	-0.0198	-0.0054
2	1.6489	-1.1352	0.0067	0.0018
3	-0.6907	0.7711	-0.0010	-0.0003
4	-0.0462	-0.0420	0.0001	0.0
5	0.0360	0.0046	0.0	0.0
SUMS	2161.8591	-5.2001	0.9015	0.2456

DAYS 109 THRU 114 JD 2444713.5 TO 2444719.5 DATES APR 19 THRU APR 24

A = 3.0 B = -37.33333333 W = 109

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1410.2612	-15.8711	0.9009	0.2455
1	1047.0586	-8.4022	0.0051	0.0014
2	-1.6545	2.9029	0.0074	0.0020
3	-0.1826	0.6161	0.0049	0.0013
4	0.1441	-0.0320	0.0007	0.0002
5	0.0162	-0.0138	-0.0028	-0.0008
SUMS	2455.6430	-20.8001	0.9162	0.2496

DAYS 115 THRU 120 JD 2444719.5 TO 2444725.5 DATES APR 25 THRU APR 30

A = 3.0 B = -39.33333333 W = 115

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1338.7011	-17.1924	0.9518	0.2593
1	1042.6529	8.1721	0.0454	0.0124
2	-0.1247	4.3897	0.0064	0.0017
3	0.1370	-0.3652	-0.0081	-0.0022
4	-0.1678	-0.1979	-0.0004	-0.0001
5	-0.0241	-0.0068	0.0036	0.0010
SUMS	2381.1744	-5.2005	0.9987	0.2721

DAYS 121 THRU 126 JD 2444725.5 TO 2444731.5 DATES MAY 1 THRU MAY 6

A = 3.0 B = -41.33333333 W = 121

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1261.7808	10.3404	1.0237	0.2789
1	1038.7051	14.3775	0.0010	0.0003
2	-2.1619	-2.9527	-0.0266	-0.0072
3	0.0353	-1.7904	0.0059	0.0016
4	0.3770	0.1259	0.0037	0.0010
5	0.0800	0.1266	-0.0044	-0.0012
SUMS	2298.8163	20.2273	1.0033	0.2734

DAYS 127 THRU 132 JD 2444731.5 TO 2444737.5 DATES MAY 7 THRU MAY 12

A = 3.0 B = -43.33333333 W = 127

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1177.2292	18.5329	0.9585	0.2611
1	1041.5184	-6.8690	-0.0476	-0.0130
2	3.6622	-4.1899	0.0035	0.0010
3	0.0923	1.1112	0.0111	0.0030
4	-0.4135	0.0442	-0.0002	0.0
5	0.0538	-0.0807	-0.0051	-0.0014
SUMS	2222.1424	8.5487	0.9202	0.2507

DAYS 133 THRU 138 JD 2444737.5 TO 2444743.5 DATES MAY 13 THRU MAY 18

A = 3.0 B = -45.33333333 W = 133

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1111.2043	-4.1010	0.9014	0.2456
1	1049.5511	-12.5205	-0.0086	-0.0023
2	-0.2778	0.7711	0.0118	0.0032
3	-0.7102	0.6311	-0.0004	-0.0001
4	0.0779	0.0020	-0.0034	-0.0009
5	0.0193	0.0113	-0.0009	-0.0002
SUMS	2159.8646	-15.2060	0.8999	0.2453

DAYS 139 THRU 144 JD 2444743.5 TO 2444749.5 DATES MAY 19 THRU MAY 24

A = 3.0 B = -47.33333333 W = 139

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1405.3960	-20.8760	0.9124	0.2486
1	1043.9933	-1.7558	0.0177	0.0048
2	-1.1416	4.3620	0.0092	0.0025
3	0.5347	0.3217	0.0033	0.0009
4	0.0799	-0.1474	-0.0028	-0.0008
5	-0.0589	-0.0205	-0.0018	-0.0005
SUMS	2448.8034	-18.1160	0.9380	0.2555

DAYS 145 THRU 150 JD 2444749.5 TO 2444755.5 DATES MAY 25 THRU MAY 30

A = 3.0 B = -49.33333333 W = 145

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1332.3872	-7.0969	0.9775	0.2663
1	1043.5564	14.1266	0.0422	0.0115
2	-0.5314	2.2862	0.0007	0.0002
3	-0.6815	-0.9920	-0.0055	-0.0015
4	-0.1210	-0.1793	-0.0026	-0.0007
5	0.0577	-0.0081	0.0005	0.0001
SUMS	2374.6674	8.1365	1.0128	0.2759

DAYS 151 THRU 156 JD 2444755.5 TO 2444761.5 DATES MAY 31 THRU JUNE 5

A = 3.0 B = -51.33333333 W = 151

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1252.3155	19.5468	1.0145	0.2764
1	1035.6422	6.3271	-0.0221	-0.0060
2	-0.7814	-6.2534	-0.0229	-0.0062
3	1.7038	-0.7057	0.0034	0.0009
4	0.2811	0.5330	0.0031	0.0008
5	-0.2002	0.0672	0.0006	0.0002
SUMS	2288.9610	19.5150	0.9766	0.2661

DAYS 157 THRU 162 JD 2444761.5 TO 2444767.5 DATES JUNE 6 THRU JUNE 11

A = 3.0 B = -53.33333333 W = 157

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1172.1085	9.9200	0.9324	0.2540
1	1046.6571	-12.0989	-0.0397	-0.0108
2	2.8368	-1.4573	0.0088	0.0024
3	-0.8707	0.9080	0.0077	0.0021
4	-0.1269	-0.1302	0.0001	0.0
5	0.0720	0.0110	-0.0037	-0.0010
SUMS	2220.6768	-2.8474	0.9056	0.2467

DAYS 163 THRU 168 JD 2444767.5 TO 2444773.5 DATES JUNE 12 THRU JUNE 17

A = 3.0 B = -55.33333333 W = 163

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1109.5728	-14.3348	0.9013	0.2456
1	1047.5936	-9.6082	0.0061	0.0017
2	-1.8052	2.5334	0.0075	0.0020
3	-0.3354	0.6740	-0.0044	-0.0012
4	0.1958	0.0025	0.0007	0.0002
5	0.0284	-0.0181	0.0025	0.0007
SUMS	2155.2500	-20.7512	0.9137	0.2490

DAYS 169 THRU 174 JD 2444773.5 TO 2444779.5 DATES JUNE 18 THRU JUNE 23

A = 3.0 B = -57.33333333 W = 169

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1398.4235	-18.7847	0.9351	0.2548
1	1043.1404	6.5436	0.0261	0.0071
2	0.5474	4.3691	0.0040	0.0011
3	0.4111	-0.4037	-0.0027	-0.0007
4	-0.2200	-0.1767	-0.0002	-0.0001
5	-0.0500	0.0190	0.0026	0.0007
SUMS	2442.2524	-8.4334	0.9649	0.2629

DAYS 175 THRU 180 JD 2444779.5 TO 2444785.5 DATES JUNE 24 THRU JUNE 29

A = 3.0 B = -59.33333333 W = 175

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1325.9790	6.3164	0.9951	0.2711
1	1042.2413	14.8832	0.0235	0.0064
2	-2.3270	-1.1711	-0.0106	-0.0029
3	-0.7391	-1.4420	0.0036	0.0010
4	0.2127	-0.1034	0.0018	0.0005
5	0.1095	0.0345	-0.0052	-0.0014
SUMS	2365.4764	18.5176	1.0082	0.2747

DAYS 181 THRU 186 JD 2444785.5 TO 2444791.5 DATES JUNE 30 THRU JULY 5

A = 3.0 B = -61.33333333 W = 181

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1241.7836	20.3144	0.9882	0.2693
1	1037.6356	-4.4200	-0.0344	-0.0094
2	2.9627	-5.6535	-0.0117	-0.0032
3	1.2790	1.0294	0.0013	0.0004
4	-0.4688	0.3354	0.0012	0.0003
5	-0.1123	-0.1322	0.0022	0.0006
SUMS	2283.0798	11.4735	0.9468	0.2580

DAYS 187 THRU 192 JD 2444791.5 TO 2444797.5 DATES JULY 6 THRU JULY 11

A = 3.0 B = -63.33333333 W = 187

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1170.6524	-1.4235	0.9130	0.2488
1	1049.1604	-13.0148	-0.0246	-0.0067
2	0.6511	0.5716	0.0129	0.0035
3	-0.9229	0.5986	0.0052	0.0014
4	0.0412	-0.0549	-0.0008	-0.0002
5	0.0249	0.0361	-0.0022	-0.0006
SUMS	2219.6071	-13.2869	0.9035	0.2462

DAYS 193 THRU 198 JD 2444797.5 TO 2444803.5 DATES JULY 12 THRU JULY 17

A = 3.0 B = -65.33333333 W = 193

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1105.6424	-20.4292	0.9145	0.2492
1	1044.0274	-3.5103	0.0186	0.0051
2	-1.7951	4.2403	0.0067	0.0018
3	0.4682	0.5273	0.0007	0.0002
4	0.2176	-0.1296	-0.0008	-0.0002
5	-0.0381	-0.0484	-0.0021	-0.0006
SUMS	2148.5224	-19.3499	0.9376	0.2555

DAYS 199 THRU 204 JD 2444803.5 TO 2444809.5 DATES JULY 18 THRU JULY 23

A = 3.0 B = -67.33333333 W = 199

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1391.7743	-9.4969	0.9634	0.2625
1	1044.1053	13.1604	0.0211	0.0057
2	0.6507	2.4315	-0.0050	-0.0014
3	-0.4690	-0.9848	0.0067	0.0018
4	-0.2208	-0.0922	0.0024	0.0007
5	0.0465	0.0164	-0.0048	-0.0013
SUMS	2435.8870	5.0344	0.9838	0.2680

DAYS 205 THRU 210 JD 2444809.5 TO 2444815.5 DATES JULY 24 THRU JULY 29

A = 3.0 B = -69.33333333 W = 205

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1317.0346	17.5567	0.9950	0.2711
1	1038.6315	8.9279	0.0024	0.0006
2	-2.3799	-4.8841	-0.0130	-0.0035
3	0.6162	-1.1548	-0.0003	-0.0001
4	0.4734	0.2393	0.0028	0.0008
5	-0.0074	0.1046	-0.0014	-0.0004
SUMS	2354.3684	20.7896	0.9855	0.2685

DAYS 211 THRU 216 JD 2444815.5 TO 2444821.5 DATES JULY 30 THRU AUG 4

A = 3.0 B = -71.33333333 W = 211

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1234.7088	13.0151	0.9552	0.2603
1	1043.7119	-11.5320	-0.0356	-0.0097
2	3.4036	-2.5019	-0.0030	-0.0008
3	-0.3813	1.2457	0.0008	0.0002
4	-0.3304	-0.0667	0.0009	0.0003
5	0.0855	-0.0565	0.0025	0.0007
SUMS	2281.1981	0.1037	0.9208	0.2510

DAYS 217 THRU 222 JD 2444821.5 TO 2444827.5 DATES AUG 5 THRU AUG 10

A = 3.0 B = -73.33333333 W = 217

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1169.9783	-12.1675	0.9040	0.2463
1	1048.2699	-10.6332	-0.0048	-0.0013
2	-1.2385	2.2145	0.0144	0.0039
3	-0.6304	0.5710	0.0005	0.0001
4	0.1312	0.0075	-0.0015	-0.0004
5	0.0326	0.0124	0.0001	0.0
SUMS	2216.5431	-19.9953	0.9127	0.2486

DAYS 223 THRU 228 JD 2444827.5 TO 2444833.5 DATES AUG 11 THRU AUG 16

A = 3.0 B = -75.33333333 W = 223

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1099.5777	-19.9274	0.9393	0.2559
1	1042.1110	4.8362	0.0328	0.0089
2	-0.1930	4.8323	0.0026	0.0007
3	0.7331	-0.1801	-0.0062	-0.0017
4	-0.0819	-0.2473	-0.0010	-0.0003
5	-0.0847	-0.0032	0.0014	0.0004
SUMS	2142.0622	-10.6895	0.9689	0.2639

DAYS 229 THRU 234 JD 2444833.5 TO 2444839.5 DATES AUG 17 THRU AUG 22

A = 3.0 B = -77.33333333 W = 229

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1385.5464	3.9482	0.9861	0.2687
1	1043.1962	15.0726	0.0077	0.0021
2	-0.9819	-0.8498	-0.0075	-0.0021
3	-0.7215	-1.3083	0.0014	0.0004
4	0.0529	-0.0035	0.0	0.0
5	0.0815	0.0189	0.0006	0.0002
SUMS	2427.1736	16.8781	0.9883	0.2693

DAYS 235 THRU 240 JD 2444839.5 TO 2444845.5 DATES AUG 23 THRU AUG 28

A = 3.0 B = -79.33333333 W = 235

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1305.6144	21.0521	0.9777	0.2664
1	1038.2834	-1.6089	-0.0181	-0.0049
2	1.1222	-5.8056	-0.0104	-0.0028
3	1.3059	0.3700	0.0042	0.0012
4	-0.1214	0.3622	0.0043	0.0012
5	-0.1468	-0.0309	-0.0033	-0.0009
SUMS	2346.0577	14.3389	0.9544	0.2602

DAYS 241 THRU 246 JD 2444845.5 TO 2444851.5 DATES AUG 29 THRU SEPT 3

A = 3.0 B = -81.33333333 W = 241

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1231.9565	1.6232	0.9255	0.2522
1	1047.9478	-13.5364	-0.0283	-0.0077
2	1.3501	0.1108	0.0047	0.0013
3	-0.7673	0.8246	0.0066	0.0018
4	-0.0334	-0.0982	0.0002	0.0001
5	0.0340	0.0102	-0.0028	-0.0008
SUMS	2280.4877	-11.0658	0.9059	0.2469

DAYS 247 THRU 252 JD 2444851.5 TO 2444857.5 DATES SEPT 4 THRU SEPT 9

A = 3.0 B = -83.33333333 W = 247

	MOON GHA	MOON CEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1167.5354	-19.5638	0.9080	0.2474
1	1045.3665	-5.2528	0.0169	0.0046
2	-1.8534	3.8059	0.0123	0.0034
3	0.0192	0.5393	-0.0075	-0.0020
4	0.1949	-0.0459	-0.0003	-0.0001
5	0.0030	-0.0247	0.0055	0.0015
SUMS	2211.2656	-20.5420	0.9349	0.2548

DAYS 253 THRU 258 JD 2444857.5 TO 2444863.5 DATES SEPT 10 THRU SEPT 15

A = 3.0 B = -85.33333333 W = 253

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1093.5960	-12.2460	0.9719	0.2648
1	1042.5313	12.4639	0.0347	0.0095
2	0.3586	3.4445	-0.0064	-0.0018
3	-0.0583	-0.9626	0.0002	0.0
4	-0.2085	-0.2178	0.0001	0.0
5	0.0083	0.0220	-0.0037	-0.0010
SUMS	2136.2274	2.5040	0.9968	0.2715

DAYS 259 THRU 264 JD 2444863.5 TO 2444869.5 DATES SEPT 16 THRU SEPT 21

A = 3.0 B = -87.33333333 W = 259

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1377.1918	16.2723	0.9951	0.2711
1	1039.3573	10.4123	-0.0121	-0.0033
2	-1.5776	-4.6237	-0.0106	-0.0029
3	0.3600	-1.0748	-0.0050	-0.0014
4	0.3353	0.2543	0.0015	0.0004
5	0.0035	0.0609	0.0059	0.0016
SUMS	2415.6703	21.3013	0.9748	0.2655

DAYS 265 THRU 270 JD 2444869.5 TO 2444875.5 DATES SEPT 22 THRU SEPT 27

A = 3.0 B = -89.33333333 W = 265

	MOON GHA	MOON CEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1296.4058	15.4003	0.9499	0.2588
1	1043.4270	-10.1765	-0.0262	-0.0071
2	2.8694	-3.2690	-0.0036	-0.0010
3	-0.1438	1.0833	0.0050	0.0014
4	-0.2775	0.0292	0.0038	0.0010
5	0.0466	-0.0475	-0.0036	-0.0010
SUMS	2342.3275	3.0198	0.9253	0.2521

DAYS 271 THRU 276 JD 2444875.5 TO 2444881.5 DATES SEPT 28 THRU OCT 3

A = 3.0 B = -91.33333333 W = 271

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1230.8184	-10.0030	0.9065	0.2470
1	1048.4470	-11.7376	-0.0137	-0.0037
2	-0.6522	1.9651	0.0062	0.0017
3	-0.5398	0.6304	0.0039	0.0011
4	0.0868	-0.0411	0.0010	0.0003
5	0.0176	0.0078	-0.0013	-0.0004
SUMS	2278.1778	-19.1784	0.9026	0.2460

DAYS 277 THRU 282 JD 2444881.5 TO 2444887.5 DATES OCT 4 THRU OCT 9

A = 3.0 B = -93.33333333 W = 277

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1162.7226	-21.1312	0.9226	0.2514
1	1043.4146	2.4896	0.0313	0.0085
2	-0.7438	4.6815	0.0126	0.0034
3	0.4294	0.1075	0.0037	0.0010
4	-0.0082	-0.1548	-0.0020	-0.0005
5	-0.0510	-0.0226	-0.0051	-0.0014
SUMS	2205.7636	-14.0300	0.9631	0.2624

DAYS 283 THRU 288 JD 2444887.5 TO 2444893.5 DATES OCT 10 THRU OCT 15

A = 3.0 B = -95.33333333 W = 283

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1088.3945	0.3729	1.0037	0.2735
1	1041.9079	16.1827	0.0256	0.0070
2	-1.2586	0.3817	-0.0168	-0.0046
3	-0.5740	-1.5907	0.0018	0.0005
4	0.0403	-0.1398	0.0003	0.0001
5	0.0795	0.0528	-0.0034	-0.0009
SUMS	2128.5896	15.2596	1.0112	0.2756

DAYS 289 THRU 294 JD 2444893.5 TO 2444899.5 DATES OCT 16 THRU OCT 21

A = 3.0 B = -97.33333333 W = 289

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1365.8589	21.5743	0.9851	0.2684
1	1037.5159	0.1980	-0.0362	-0.0099
2	1.6037	-6.1511	-0.0030	-0.0008
3	1.3245	0.4173	0.0053	0.0014
4	-0.1844	0.3819	-0.0010	-0.0003
5	-0.1514	-0.0715	0.0	0.0
SUMS	2405.9672	16.3489	0.9502	0.2588

DAYS 295 THRU 300 JD 2444899.5 TO 2444905.5 DATES OCT 22 THRU OCT 27

A = 3.0 B = -99.33333333 W = 295

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1291.9696	4.2711	0.9235	0.2516
1	1048.1069	-13.4866	-0.0220	-0.0060
2	1.3746	-0.5126	0.0031	0.0009
3	-0.7696	0.8335	-0.0032	-0.0009
4	-0.0064	-0.0569	0.0005	0.0001
5	0.0324	0.0064	0.0027	0.0007
SUMS	2340.7075	-8.9451	0.9046	0.2464

DAYS 301 THRU 306 JD 2444905.5 TO 2444911.5 DATES OCT 28 THRU NOV 2

A = 3.0 B = -101.33333333 W = 301

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1228.3055	-18.7730	0.8997	0.2451
1	1046.2553	-6.8291	0.0013	0.0004
2	-1.4420	3.5726	0.0082	0.0022
3	0.0634	0.5102	0.0037	0.0010
4	0.1549	-0.0738	0.0004	0.0001
5	-0.0069	-0.0105	-0.0021	-0.0006
SUMS	2273.3302	-21.6036	0.9112	0.2482

DAYS 307 THRU 312 JD 2444911.5 TO 2444917.5 DATES NOV 3 THRU NOV 8

A = 3.0 B = -103.33333333 W = 307

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1157.3207	-15.6417	0.9455	0.2576
1	1044.0512	10.2304	0.0437	0.0119
2	0.0746	3.9284	0.0066	0.0018
3	-0.1784	-0.4968	0.0002	0.0001
4	-0.1924	-0.1662	0.0003	0.0001
5	0.0010	-0.0096	-0.0029	-0.0008
SUMS	2201.0767	-2.1555	0.9934	0.2707

DAYS 313 THRU 318 JD 2444917.5 TO 2444923.5 DATES NOV 9 THRU NOV 14

A = 3.0 B = -105.33333333 W = 313

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1081.7849	13.4682	1.0230	0.2787
1	1037.9962	13.6104	0.0076	0.0021
2	-2.8657	-3.8804	-0.0272	-0.0074
3	0.2881	-1.8406	-0.0021	-0.0006
4	0.5070	0.1795	0.0043	0.0012
5	0.0647	0.1532	0.0015	0.0004
SUMS	2117.7752	21.6903	1.0071	0.2744

DAYS 319 THRU 324 JD 2444923.5 TO 2444929.5 DATES NOV 15 THRU NOV 20

A = 3.0 B = -107.33333333 W = 319

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1355.9158	17.4029	0.9633	0.2625
1	1041.8269	-9.3155	-0.0429	-0.0117
2	4.0156	-3.7907	0.0053	0.0014
3	-0.2084	1.2999	-0.0023	-0.0006
4	-0.4370	-0.0209	-0.0027	-0.0007
5	0.1037	-0.0831	0.0047	0.0013
SUMS	2401.2166	5.4926	0.9254	0.2522

DAYS 325 THRU 330 JD 2444929.5 TO 2444935.5 DATES NOV 21 THRU NOV 26

A = 3.0 B = -109.33333333 W = 325

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1290.1564	-7.8497	0.9047	0.2465
1	1049.0464	-12.5334	-0.0129	-0.0035
2	-0.6349	1.4891	0.0087	0.0024
3	-0.6348	0.6726	-0.0015	-0.0004
4	0.1245	-0.0084	-0.0014	-0.0004
5	0.0176	-0.0018	0.0007	0.0002
SUMS	2338.0752	-18.2316	0.8983	0.2448

DAYS 331 THRU 336 JD 2444935.5 TO 2444941.5 DATES NOV 27 THRU DEC 2

A = 3.0 B = -111.33333333 W = 331

	MOON GHA	MOON DEC	MOON H P	MOON S D
TERM	DEG	DEG	DEG	DEG
0	1223.2166	-21.8803	0.9063	0.2469
1	1044.2555	0.6456	0.0128	0.0035
2	-0.3386	4.5131	0.0083	0.0023
3	0.5877	0.0596	0.0078	0.0021
4	-0.0313	-0.1559	-0.0006	-0.0002
5	-0.0716	0.0029	-0.0049	-0.0013
SUMS	2267.6183	-16.8150	0.9297	0.2533

DAYS 337 THRU 342 JD 2444941.5 TO 2444947.5 DATES DEC 3 THRU DEC 8

A = 3.0 B = -113.33333333 W = 337

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1152.6898	-4.3369	0.9713	0.2646
1	1044.6942	15.0141	0.0468	0.0128
2	-1.1404	1.7095	0.0010	0.0003
3	-0.8988	-0.9890	-0.0069	-0.0019
4	-0.0778	-0.1894	-0.0004	-0.0001
5	0.0588	-0.0266	0.0017	0.0005
SUMS	2195.3258	11.1817	1.0135	0.2762

DAYS 343 THRU 348 JD 2444947.5 TO 2444953.5 DATES DEC 9 THRU DEC 14

A = 3.0 B = -115.33333333 W = 343

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1071.7383	21.3274	1.0210	0.2782
1	1034.1470	4.1489	-0.0166	-0.0045
2	-0.4966	-7.0563	-0.0217	-0.0059
3	2.2704	-0.4507	0.0030	0.0008
4	0.2007	0.6499	0.0	0.0
5	-0.3038	0.0397	-0.0009	-0.0003
SUMS	2107.5560	18.6589	0.9848	0.2683

DAYS 349 THRU 354 JD 2444953.5 TO 2444959.5 DATES DEC 15 THRU DEC 20

A = 3.0 B = -117.33333333 W = 349

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1350.9916	6.9035	0.9388	0.2558
1	1046.9761	-13.6103	-0.0405	-0.0110
2	2.6341	-0.7545	0.0088	0.0024
3	-1.0492	0.9263	0.0018	0.0005
4	-0.0671	-0.1536	-0.0010	-0.0003
5	0.0767	0.0232	0.0	0.0
SUMS	2399.5622	-6.6654	0.9079	0.2474

DAYS 355 THRU 360 JD 2444959.5 TO 2444965.5 DATES DEC 21 THRU DEC 26

A = 3.0 B = -119.33333333 W = 355

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1287.8087	-17.5107	0.8994	0.2451
1	1046.8041	-8.2346	-0.0003	-0.0001
2	-1.7422	3.2437	0.0085	0.0023
3	-0.0808	0.6201	0.0024	0.0006
4	0.2336	-0.0387	-0.0010	-0.0003
5	0.0140	-0.0267	-0.0031	-0.0008
SUMS	2333.0374	-21.9469	0.9059	0.2468

DAYS 360 THRU 365 JD 2444964.5 TO 2444970.5 DATES DEC 26 THRU DEC 31

A = 3.0 B = -121.00000000 W = 360

TERM	MOON GHA DEG	MOON DEC DEG	MOON H P DEG	MOON S D DEG
0	1229.0287	-20.0349	0.9173	0.2499
1	1044.2110	5.8646	0.0199	0.0054
2	0.6931	4.3250	0.0068	0.0019
3	0.4244	-0.3758	0.0005	0.0001
4	-0.2056	-0.1587	-0.0010	-0.0003
5	-0.0467	0.0294	-0.0005	-0.0001
SUMS	2274.1049	-10.3504	0.9430	0.2569

Section D: ASTRONOMICAL TABLES

With two exceptions the series in this section provide data referred to the true equinox and equator of date. The exceptions are

1. the Moon's geocentric, rectangular coordinates (X, Y, Z), which are referred to the mean equinox and equator of 1950.0;
2. the right ascension and declination of Pluto, which are astrometric (*i.e.*, free of stellar aberration, except for the elliptic part) and are referred to the mean equinox and equator of 1950.0.

The unit of distance for the Sun and planets is the Astronomical Unit; the unit of distance for the Moon is the Earth's radius.

CHEBYSHEV APPROXIMATION OF SIDEREAL TIME FOR YEAR 1981

DAYS 1 THRU 95 JD 2444605.5 TO 2444700.5 DATES JAN 1 THRU APR 5

A = 47.5 B = -1.02105263 W = 1

	APP S T	EQ OF EQ	NUT LON	NUT OBL
TERM	H	S	''	''
0	19.65005927	-1.5759	-25.7648	-11.5911
1	3.12119825	-0.0661	-1.0808	0.9130
2	-0.00001169	-0.0421	-0.6879	-0.1344
3	0.00000203	0.0073	0.1196	-0.0637
4	-0.00000016	-0.0006	-0.0093	0.0226
5	0.00000013	0.0005	0.0078	0.0123
6	-0.00000056	-0.0020	-0.0327	0.0165
7	-0.00000006	-0.0002	-0.0033	-0.0027
8	-0.00000043	-0.0016	-0.0254	0.0148
9	-0.00000065	-0.0024	-0.0385	-0.0180
10	-0.00000076	-0.0027	-0.0445	-0.0028
11	-0.00000048	-0.0017	-0.0285	-0.0246
12	0.00000100	0.0036	0.0589	-0.0112
13	-0.00000009	-0.0003	-0.0052	-0.0029
14	0.00000080	0.0029	0.0472	-0.0147
15	0.00000060	0.0022	0.0352	0.0251
16	-0.00000056	-0.0020	-0.0331	0.0065
17	0.00000025	0.0009	0.0146	0.0052
18	-0.00000087	-0.0031	-0.0509	0.0142
19	-0.00000064	-0.0023	-0.0376	-0.0322
20	0.00000136	0.0049	0.0802	-0.0150
21	0.00000046	0.0017	0.0273	0.0296
22	-0.00000088	-0.0032	-0.0516	0.0102
23	-0.00000032	-0.0012	-0.0191	-0.0138
24	0.00000030	0.0011	0.0179	-0.0070
25	0.00000020	0.0007	0.0116	0.0037
26	-0.00000007	-0.0003	-0.0043	0.0028
27	-0.00000002	-0.0001	-0.0014	-0.0011
28	0.00000004	0.0002	0.0026	0.0014
29	-0.00000011	-0.0004	-0.0063	0.0011
30	-0.00000005	-0.0002	-0.0027	-0.0034
31	0.00000014	0.0005	0.0083	-0.0011
32	0.00000004	0.0001	0.0023	0.0031
33	-0.00000010	-0.0004	-0.0058	0.0009
34	-0.00000003	-0.0001	-0.0017	-0.0017
35	0.00000004	0.0001	0.0024	-0.0006
SUMS	22.77124638	-1.6822	-27.4995	-10.8590

DAYS 91 THRU 185 JD 2444695.5 TO 2444790.5 DATES APR 1 THRU JULY 4

A = 47.5 B = -2.91578947 W = 91

	APP S T	EQ OF EQ	NUT LON	NUT OBL
TERM	H	S	"	"
0	31.47776579	-1.7981	-29.3968	-10.7664
1	3.12121886	0.0081	0.1319	-0.2487
2	0.00001076	0.0387	0.6330	0.1265
3	-0.00000091	-0.0033	-0.0534	0.0582
4	0.00000044	0.0016	0.0259	-0.0065
5	0.00000070	0.0025	0.0412	-0.0047
6	0.00000103	0.0037	0.0607	0.0019
7	0.00000024	0.0009	0.0139	0.0092
8	0.00000089	0.0032	0.0523	0.0016
9	-0.00000084	-0.0030	-0.0496	0.0195
10	0.00000034	0.0012	0.0200	0.0006
11	0.00000026	0.0009	0.0153	0.0347
12	-0.00000110	-0.0040	-0.0646	-0.0021
13	-0.00000018	-0.0006	-0.0106	0.0020
14	-0.00000116	-0.0042	-0.0682	-0.0024
15	0.00000018	0.0007	0.0107	-0.0323
16	0.00000056	0.0020	0.0331	0.0007
17	0.00000011	0.0004	0.0063	-0.0109
18	0.00000118	0.0042	0.0694	0.0026
19	-0.00000020	-0.0007	-0.0119	0.0359
20	-0.00000138	-0.0050	-0.0812	-0.0020
21	0.00000013	0.0005	0.0076	-0.0292
22	0.00000095	0.0034	0.0560	0.0013
23	-0.00000009	-0.0003	-0.0052	0.0187
24	-0.00000055	-0.0020	-0.0322	-0.0012
25	0.00000005	0.0002	0.0029	-0.0085
26	0.00000016	0.0006	0.0092	0.0005
27	0.0	0.0	0.0001	0.0002
28	0.00000009	0.0003	0.0055	0.0003
29	-0.00000003	-0.0001	-0.0016	0.0038
30	-0.00000018	-0.0006	-0.0103	-0.0006
31	0.00000003	0.0001	0.0017	-0.0044
32	0.00000016	0.0006	0.0095	0.0005
33	-0.00000002	-0.0001	-0.0013	0.0033
34	-0.00000010	-0.0004	-0.0059	-0.0004
35	0.00000001	0.0	0.0007	-0.0016
SUMS	34.59899618	-1.7486	-28.5859	-10.7999

CHEBYSHEV APPROXIMATION OF SIDEREAL TIME FOR YEAR 1981

DAYS 182 THRU 276 JD 2444786.5 TO 2444881.5 DATES JULY 1 THRU OCT 3

A = 47.5 B = -4.83157895 W = 182

TERM	APP S T H	EQ OF EQ S	NUT LON "	NUT OBL "
0	43.43695758	-1.7840	-29.1664	-9.0722
1	3.12119950	-0.0616	-1.0078	0.9518
2	-0.00001010	-0.0364	-0.5946	-0.1064
3	0.00000006	0.0002	0.0037	-0.0668
4	0.00000025	0.0009	0.0147	-0.0164
5	-0.00000064	-0.0023	-0.0376	0.0071
6	-0.00000080	-0.0029	-0.0471	-0.0282
7	0.00000021	0.0008	0.0126	-0.0002
8	-0.00000072	-0.0026	-0.0424	-0.0252
9	0.00000119	0.0043	0.0700	-0.0055
10	0.00000022	0.0008	0.0132	-0.0009
11	0.00000082	0.0029	0.0480	-0.0129
12	0.00000011	0.0004	0.0062	0.0190
13	0.00000014	0.0005	0.0085	-0.0010
14	0.00000042	0.0015	0.0246	0.0237
15	-0.00000112	-0.0040	-0.0660	0.0121
16	-0.00000029	-0.0011	-0.0172	-0.0142
17	-0.00000023	-0.0008	-0.0134	0.0006
18	-0.00000041	-0.0015	-0.0239	-0.0240
19	0.00000134	0.0048	0.0789	-0.0178
20	0.00000079	0.0028	0.0463	0.0343
21	-0.00000119	-0.0043	-0.0700	0.0184
22	-0.00000050	-0.0018	-0.0292	-0.0217
23	0.00000059	0.0021	0.0348	-0.0069
24	0.00000008	0.0003	0.0047	0.0087
25	-0.00000020	-0.0007	-0.0118	-0.0002
26	0.00000003	0.0001	0.0015	-0.0028
27	0.00000006	0.0002	0.0035	-0.0005
28	0.00000007	0.0003	0.0044	0.0009
29	-0.00000001	0.0	-0.0008	0.0032
30	-0.00000015	-0.0005	-0.0088	0.0
31	-0.00000001	0.0	-0.0005	-0.0037
32	0.00000013	0.0005	0.0075	-0.0003
33	0.00000001	0.0	0.0005	0.0024
34	-0.00000007	-0.0002	-0.0039	0.0002
35	0.0	0.0	0.0002	-0.0010
SUMS	46.55814716	-1.8813	-30.7576	-8.3464

DAYS 274 THRU 368 JD 2444878.5 TO 2444973.5 DATES OCT 1 THRU JAN 3

A = 47.5 B = -6.76842105 W = 274

TERM	APP S T H	EQ OF EQ S	NUT LON "	NUT OBL "
0	7.52750603	-1.9966	-32.6436	-8.0037
1	3.12122216	0.0199	0.3260	-0.2115
2	0.00001073	0.0386	0.6315	0.1189
3	-0.00000097	-0.0035	-0.0570	0.1021
4	-0.00000169	-0.0061	-0.0992	0.0077
5	0.0	0.0	-0.0002	0.0054
6	-0.00000061	-0.0022	-0.0360	0.0205
7	-0.00000027	-0.0010	-0.0159	-0.0019
8	-0.00000024	-0.0008	-0.0138	0.0195
9	-0.00000031	-0.0011	-0.0183	-0.0145
10	-0.00000083	-0.0030	-0.0490	-0.0032
11	-0.00000075	-0.0027	-0.0443	-0.0229
12	0.00000092	0.0033	0.0539	-0.0111
13	-0.00000002	-0.0001	-0.0012	-0.0015
14	0.00000079	0.0028	0.0464	-0.0165
15	0.00000068	0.0024	0.0397	0.0242
16	-0.00000058	-0.0021	-0.0340	0.0090
17	0.00000017	0.0006	0.0099	0.0034
18	-0.00000093	-0.0034	-0.0550	0.0161
19	-0.00000076	-0.0027	-0.0449	-0.0331
20	0.00000150	0.0054	0.0882	-0.0207
21	0.00000063	0.0023	0.0370	0.0306
22	-0.00000089	-0.0032	-0.0524	0.0133
23	-0.00000038	-0.0014	-0.0224	-0.0119
24	0.00000022	0.0008	0.0128	-0.0074
25	0.00000020	0.0007	0.0118	0.0016
26	-0.00000005	-0.0002	-0.0029	0.0028
27	-0.00000001	0.0	-0.0005	-0.0022
28	0.00000014	0.0005	0.0084	0.0014
29	-0.00000012	-0.0004	-0.0068	0.0046
30	-0.00000019	-0.0007	-0.0109	-0.0028
31	0.00000010	0.0004	0.0061	-0.0043
32	0.00000014	0.0005	0.0083	0.0015
33	-0.00000003	-0.0001	-0.0020	0.0027
34	-0.00000008	-0.0003	-0.0045	-0.0002
35	0.00000001	0.0	0.0004	-0.0013
SUMS	10.64873471	-1.9534	-31.9344	-7.9854

DAYS 1 THRU 95 JD 2444605.5 TO 2444700.5 DATES JAN 1 THRU APR 5

A = 47.5 B = -1.02105263 W = 1

TERM	R A	DEC	DISTANCE	S D	EPHEM TR
	H	DEG	AU	"	H
0	43.9254484	-20.255387	1.98040298	32.35777	24.2756817
1	3.1026951	15.163946	0.00900594	-0.14688	-0.0220451
2	-0.0922231	1.784187	0.00188360	-0.03015	-0.0914872
3	0.0123036	-0.489172	-0.00027578	0.00478	0.0126724
4	0.0042358	-0.000770	-0.00001459	0.00023	0.0041572
5	-0.0007127	0.005156	0.00000879	-0.00015	-0.0007129
6	-0.0000033	-0.001120	-0.00000168	0.00003	0.0000002
7	0.0000648	0.000304	0.00000483	-0.00008	0.0000663
8	0.0000245	0.000121	-0.00001786	0.00029	0.0000170
9	-0.0000673	-0.000217	-0.00000696	0.00011	-0.0000691
10	-0.0000172	-0.000143	0.00001229	-0.00020	-0.0000107
11	0.0000296	0.000087	0.00000276	-0.00004	0.0000310
12	0.0000058	0.000063	-0.00000393	0.00006	0.0000029
13	-0.0000073	-0.000021	-0.00000096	0.00002	-0.0000076
14	-0.0000010	-0.000009	0.00000065	-0.00001	-0.0000013
15	0.0000013	-0.000001	0.00000032	-0.00001	0.0000008
16	-0.0000003	0.000003	-0.00000004	0.0	-0.0000003
17	0.0000001	0.000001	0.00000019	0.0	0.0
18	0.0000005	-0.000004	0.00000008	0.0	0.0000014
19	-0.0000006	0.000004	-0.00000033	0.00001	0.0000003
20	0.0000002	0.000007	-0.00000008	0.0	-0.0000011
21	0.0000002	-0.000002	0.00000024	0.0	-0.0000003
22	-0.0000001	-0.000002	0.00000004	0.0	0.0000007
23	-0.0000002	-0.000001	-0.00000012	0.0	0.0
SUMS	46.9517768	-3.792970	1.99100038	32.18578	24.1782963

DAYS 91 THRU 185 JD 2444695.5 TO 2444790.5 DATES APR 1 THRU JULY 4

A = 47.5 B = -2.91578947 W = 91

TERM	R A	DEC	DISTANCE	S D	EPHEM TR
	H	DEG	AU	"	H
0	7.4970751	33.136536	2.01965921	31.72876	24.0191114
1	3.1309387	9.483419	0.00893740	-0.14065	0.0120752
2	0.0653804	-2.986042	-0.00180610	0.02896	0.0649422
3	-0.0068517	-0.292081	-0.00024357	0.00358	-0.0072411
4	-0.0049429	0.036491	0.00003832	-0.00061	-0.0049272
5	0.0001545	0.006155	0.00000281	-0.00003	0.0001725
6	0.0001657	0.000038	-0.00000289	0.00005	0.0001659
7	0.0000653	-0.000056	0.00000106	-0.00002	0.0000642
8	0.0000011	0.000116	-0.00001950	0.00031	-0.0000084
9	-0.0000738	-0.000250	-0.00000159	0.00002	-0.0000736
10	-0.0000048	-0.000016	0.00001306	-0.00020	0.0000001
11	0.0000305	0.000139	0.00000076	-0.00001	0.0000304
12	0.0000016	-0.000006	-0.00000431	0.00007	0.0000009
13	-0.0000089	-0.000038	-0.00000020	0.0	-0.0000093
14	-0.0000022	-0.000003	0.00000122	-0.00002	-0.0000001
15	0.0000019	0.000005	0.00000001	0.0	0.0000025
16	0.0000006	-0.000006	0.00000001	0.0	0.0000005
17	0.0000018	0.0	0.00000001	0.0	0.0000014
18	0.0000016	0.000008	-0.00000046	0.00001	-0.0000003
19	-0.0000023	0.0	0.0	0.0	-0.0000024
20	-0.0000015	-0.000003	0.00000041	-0.00001	0.0000001
21	0.0000016	0.000001	-0.00000001	0.0	0.0000014
22	0.0000009	0.000003	-0.00000023	0.0	-0.0000002
23	-0.0000006	0.000001	0.00000001	0.0	-0.0000009
SUMS	10.6819326	39.384411	2.02657543	31.62021	24.0843052

DAYS 182 THRU 276 JD 2444786.5 TO 2444881.5 DATES JULY 1 THRU OCT 3

A = 47.5 B = -4.83157895 W = 182

TERM	R A (H)	DEC (DEG)	DISTANCE (AU)	S D (')	EPHEM TR (H)
0	19.4339056	22.793011	2.02072608	31.71188	23.9947995
1	2.9873973	-14.053824	-0.00845059	0.13286	-0.1361793
2	-0.0644904	-1.956342	-0.00190059	0.03035	-0.0637942
3	0.0111041	0.378262	0.00022719	-0.00332	0.0114144
4	0.0037730	0.010618	0.00003796	-0.00059	0.0037263
5	-0.0004082	-0.002738	-0.00000844	0.00012	-0.0004149
6	-0.0000333	0.000620	-0.00000234	0.00004	-0.0000300
7	0.0000562	-0.000131	-0.00000556	0.00009	0.0000536
8	-0.0000376	0.000105	-0.00001691	0.00026	-0.0000436
9	-0.0000611	0.000244	0.00000844	-0.00013	-0.0000580
10	0.0000254	-0.000007	0.00001213	-0.00019	0.0000303
11	0.0000291	-0.000135	-0.00000356	0.00005	0.0000262
12	-0.0000089	-0.000017	-0.00000389	0.00006	-0.0000104
13	-0.0000058	0.000028	0.00000105	-0.00002	-0.0000059
14	0.0000032	0.000004	0.00000050	-0.00001	0.0000025
15	-0.0000007	0.0	-0.00000028	0.0	-0.0000003
16	-0.0000006	0.0	-0.00000006	0.0	0.0
17	-0.0000008	0.000010	-0.00000009	0.0	-0.0000006
18	-0.0000011	0.0	0.00000027	0.0	-0.0000002
19	0.0000022	-0.000012	0.00000020	0.0	0.0000014
20	0.0000014	-0.000003	-0.00000024	0.0	0.0000002
21	-0.0000018	0.000008	-0.00000017	0.0	-0.0000011
22	-0.0000008	0.000002	0.00000011	0.0	-0.0000001
23	0.0000011	-0.000004	0.00000008	0.0	0.0000004
SUMS	22.3712475	7.169699	2.01062129	31.87145	23.8095162

DAYS 274 THRU 368 JD 2444878.5 TO 2444973.5 DATES OCT 1 THRU JAN 3

A = 47.5 B = -6.76842105 W = 274

TERM	R A (H)	DEC (DEG)	DISTANCE (AU)	S D (')	EPHEM TR (H)
0	31.2449503	-31.878444	1.98081177	32.35114	23.7197183
1	3.2537953	-10.255969	-0.00918077	0.14968	0.1363008
2	0.1019712	3.055565	0.00183349	-0.02930	0.1014261
3	-0.0085950	0.411121	0.00027871	-0.00482	-0.0091112
4	-0.0066010	-0.036423	-0.00002116	0.00033	-0.0066146
5	-0.0001275	-0.011031	-0.00001667	0.00028	-0.0001082
6	0.0002219	-0.000562	-0.00000067	0.00002	0.0002270
7	0.0000515	0.000083	-0.00001139	0.00019	0.0000465
8	-0.0000766	0.000271	-0.00000721	0.00012	-0.0000794
9	-0.0000289	0.000134	0.00001705	-0.00028	-0.0000215
10	0.0000479	-0.000212	0.00000462	-0.00008	0.0000509
11	0.0000117	-0.000029	-0.00000768	0.00013	0.0000100
12	-0.0000137	0.000083	-0.00000150	0.00003	-0.0000155
13	-0.0000045	0.000017	0.00000155	-0.00003	-0.0000036
14	0.0000026	-0.000015	0.00000051	-0.00001	0.0000021
15	0.0000018	-0.000008	-0.00000014	0.0	0.0000009
16	-0.0000016	0.000006	0.00000002	0.0	-0.0000007
17	0.0000010	-0.000005	0.00000030	0.0	0.0000008
18	0.0000002	-0.000007	-0.00000031	0.00001	0.0000008
19	-0.0000019	0.000014	-0.00000038	0.00001	-0.0000009
20	0.0000004	0.000003	0.00000026	0.0	-0.0000006
21	0.0000013	-0.000011	0.00000023	0.0	0.0000007
22	-0.0000001	-0.000002	-0.00000010	0.0	0.0000003
23	-0.0000007	0.000005	-0.00000010	0.0	-0.0000003
SUMS	34.5856056	-38.715416	1.97370043	32.46742	23.9418287

CHEBYSHEV APPROXIMATION OF LUNAR COORDINATES FOR YEAR 1981

DAYS 1 THRU 32 JD 2444605.5 TO 2444637.5 DATES JAN 1 THRU FEB 1

A = 16.0 B = -1.06250000 W = 1

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	"	E RAD	E RAD	E RAD
0	57.38566899	-14.2478538	112.3958970	-22.6385061	-46.7416830	-15.3531776
1	14.08007252	1.2148185	-0.1364334	-7.6155835	2.0075158	1.3353390
2	-0.24942305	-14.7496520	-1.7548835	-17.5434308	-45.9576448	-15.4551870
3	-0.20168398	-8.0909156	1.3159858	45.7676153	-13.6553409	-8.3742135
4	0.07470438	8.2522253	0.9811825	9.1289289	25.1207846	8.4632767
5	0.09004206	1.7651862	-0.0845798	-11.8356492	2.9929504	1.9682436
6	0.07709936	-1.7867596	-0.1555154	-1.0043767	-4.3544785	-1.5081054
7	-0.04165309	-0.1336745	-0.0971859	1.7303831	-0.1041234	-0.1665684
8	-0.04037537	0.3559750	0.0311838	-0.0135818	0.6241068	0.2278674
9	0.01848055	0.0845366	0.0376896	-0.2590366	-0.0226787	0.0110443
10	0.01095869	-0.0613136	-0.0123943	0.0016166	-0.0940671	-0.0343230
11	-0.00595712	-0.0632987	-0.0105120	0.0377245	-0.0041786	-0.0043378
12	-0.00328226	0.0144194	0.0038590	0.0060583	0.0135771	0.0044863
13	0.00107585	0.0280632	0.0025540	-0.0056620	0.0041545	0.0019356
14	0.00147002	-0.0057344	-0.0008381	-0.0029077	-0.0023796	-0.0006491
15	-0.00003588	-0.0097256	-0.0005938	0.0011521	-0.0015659	-0.0006560
16	-0.00071273	0.0015909	0.0001202	0.0009213	0.0005549	0.0001332
17	-0.00003487	0.0031376	0.0001552	-0.0002789	0.0004433	0.0001821
18	0.00029973	-0.0000568	-0.0000022	-0.0002383	-0.0001321	-0.0000304
19	0.00002275	-0.0010998	-0.0000456	0.0000621	-0.0001078	-0.0000438
20	-0.00010815	-0.0001839	-0.0000055	0.0000558	0.0000269	0.0000057
21	-0.00001932	0.0004236	0.0000134	-0.0000109	0.0000250	0.0000098
22	0.00003685	0.0001201	0.0000025	-0.0000130	-0.0000041	-0.0000005
23	0.00001409	-0.0001589	-0.0000035	0.0000010	-0.0000061	-0.0000023
24	-0.00001317	-0.0000579	-0.0000009	0.0000033	0.0000002	-0.0000001
25	-0.00000797	0.0000540	0.0000009	0.0000001	0.0000017	0.0000006
26	0.00000484	0.0000273	0.0000002	-0.0000009	0.0000002	0.0000001
27	0.00000377	-0.0000168	-0.0000001	-0.0000002	-0.0000004	-0.0000002
28	-0.00000168	-0.0000127	-0.0000003	0.0000002	-0.0000001	0.0
29	-0.00000168	0.0000050	0.0000001	0.0	0.0000001	0.0
30	0.00000046	0.0000060	0.0000001	0.0	0.0	0.0
31	0.00000076	-0.0000013	-0.0000001	0.0	0.0	0.0
32	-0.00000009	-0.0000026	0.0	0.0	0.0	-0.0000001
33	-0.00000033	0.0000004	0.0	0.0	-0.0000001	-0.0000001
SUMS	71.19664493	-27.4299294	112.5156499	-4.2447540	-80.1742497	-28.8847709

DAYS 32 THRU 63 JD 2444636.5 TO 2444668.5 DATES FEB 1 THRU MAR 4

A = 16.0 B = -3.00000000 W = 32

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	"	E RAD	E RAD	E RAD
0	63.80877091	-16.0086122	114.1359534	14.8741934	-42.9287133	-16.7777776
1	14.03694692	-1.1048669	-0.3216889	-6.8623994	-4.2847870	-1.0751695
2	-0.30558358	-16.7273224	0.2045785	24.4620604	-42.3639362	-17.2510403
3	0.06217289	5.0379405	2.3316721	42.9127433	23.5040480	5.3733856
4	0.17071507	8.7539755	0.0889291	-13.6948423	22.3128055	9.1653688
5	0.07131932	-1.8486764	-0.2634960	-9.6512290	-6.4207025	-1.6148848
6	-0.05226220	-0.9620258	-0.0575813	2.7898161	-2.6256320	-1.1673846
7	-0.05532429	0.5993070	-0.0934847	0.5727589	1.1382473	0.3710868
8	0.02288358	0.0314928	0.0307624	-0.4890760	0.0098510	0.0402982
9	0.01194497	-0.1520993	0.0212396	0.0409462	-0.1703770	-0.0651394
10	-0.00946955	-0.0296569	-0.0160982	0.0555598	0.0218033	0.0037608
11	-0.00055967	0.0385621	0.0002711	-0.0054407	0.0109760	0.0044155
12	0.00336965	0.0119603	0.0043315	-0.0005991	0.0007717	0.0003315
13	-0.00006405	-0.0145419	-0.0009106	-0.0021003	0.0005545	0.0003586
14	-0.00117304	-0.0008303	-0.0004818	-0.0000797	-0.0015949	-0.0005758
15	0.00005800	0.0054891	0.0001949	0.0010163	0.0002830	0.0000270
16	0.00042550	-0.0007851	-0.0000082	-0.0003059	0.0004681	0.0001936
17	-0.00009584	-0.0017227	0.0000076	-0.0002089	-0.0002058	-0.0000595
18	-0.00014711	0.0004678	-0.0000029	0.0001176	-0.0000626	-0.0000316
19	0.00006476	0.0005028	-0.0000142	0.0000157	0.0000522	0.0000177
20	0.00004553	-0.0002248	0.0000074	-0.0000219	-0.0000004	0.0000016
21	-0.00002997	-0.0001470	0.0000030	0.0000019	-0.0000069	-0.0000026
22	-0.00001281	0.0001048	-0.0000030	0.0000019	0.0000010	0.0000001
23	0.00001275	0.0000392	0.0000002	-0.0000002	0.0000002	0.0
24	0.00000314	-0.0000441	0.0000005	-0.0000001	0.0000003	0.0000001
25	-0.00000543	-0.0000080	-0.0000001	-0.0000002	0.0	-0.0000001
26	-0.00000044	0.0000171	0.0	0.0000001	-0.0000001	0.0
27	0.00000220	0.0000006	0.0	0.0000001	0.0	0.0
28	-0.00000015	-0.0000066	0.0000002	-0.0000001	0.0000001	0.0
29	-0.00000084	0.0000007	0.0	0.0	0.0	0.0
30	0.00000017	0.0000024	0.0000001	0.0	-0.0000001	-0.0000001
31	0.00000031	-0.0000007	0.0	-0.0000001	0.0	0.0000001
32	-0.00000011	-0.0000007	0.0	0.0	0.0000001	0.0
33	-0.00000009	0.0000002	0.0	-0.0000001	0.0	0.0
SUMS	77.76400650	-22.3717089	116.0641817	55.0029277	-51.7961565	-22.9928199

CHEBYSHEV APPROXIMATION OF LUNAR COORDINATES FOR YEAR 1981

DAYS 60 THRU 91 JD 2444664.5 TO 2444696.5 DATES MAR 1 THRU APR 1

A = 16.0 B = -4.75000000 W = 60

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	'	E RAD	E RAD	E RAD
0	64.96855456	-15.4553539	114.2755963	19.8768231	-40.1791333	-16.2612594
1	14.02220424	-1.5986059	-0.5615144	-5.7909100	-5.3850286	-1.6426615
2	-0.35653236	-15.9271979	0.3987164	31.3287006	-38.5073585	-16.4274264
3	0.09362295	7.4567084	2.6446277	38.5907279	29.2350685	7.8783669
4	0.19191115	8.1761253	-0.2289008	-17.3569382	19.9240380	8.6194815
5	0.02344677	-2.4501965	-0.2516459	-8.2621768	-7.7838485	-2.2313146
6	-0.06873737	-0.6648972	0.1700418	3.2535269	-1.9591960	-0.9648119
7	-0.02721512	0.6336137	-0.1468689	0.1949678	1.1959062	0.4224399
8	0.02699302	-0.1300640	-0.0285123	-0.4505878	-0.1750388	-0.0302465
9	0.00263528	-0.1249712	0.0487591	0.1394423	-0.1174330	-0.0534489
10	-0.00808196	0.0390532	-0.0127825	0.0136227	0.0625350	0.0218394
11	0.00257433	0.0185076	-0.0063382	-0.0225636	-0.0145440	-0.0036334
12	0.00205709	-0.0079103	0.0059906	0.0142152	-0.0034492	-0.0023159
13	-0.00130769	-0.0039728	-0.0010029	-0.0018278	0.0074121	0.0028520
14	-0.00049812	0.0033119	-0.0007374	-0.0032139	-0.0025028	-0.0006770
15	0.00046946	0.0010559	0.0006723	0.0018269	-0.0007559	-0.0004133
16	0.00008472	-0.0015883	-0.0001919	-0.0000219	0.0009178	0.0003376
17	-0.00018400	-0.0001062	-0.0000929	-0.0004103	-0.0002091	-0.0000464
18	0.00001367	0.0006023	0.0001045	0.0001730	-0.0001114	-0.0000537
19	0.00006829	-0.0000954	-0.0000275	0.0000094	0.0000911	0.0000329
20	-0.00002070	-0.0001900	-0.0000161	-0.0000413	-0.0000200	-0.0000044
21	-0.00002040	0.0000814	0.0000152	0.0000191	-0.0000109	-0.0000054
22	0.00001177	0.0000494	-0.0000029	0.0000003	0.0000106	0.0000038
23	0.00000461	-0.0000411	-0.0000025	-0.0000051	-0.0000026	-0.0000006
24	-0.00000527	-0.0000081	0.0000019	0.0000022	-0.0000015	-0.0000007
25	-0.00000055	0.0000163	-0.0000004	0.0000002	0.0000012	0.0000005
26	0.00000209	-0.0000009	-0.0000003	-0.0000005	-0.0000002	-0.0000002
27	-0.00000025	-0.0000054	0.0000003	0.0000003	-0.0000001	-0.0000002
28	-0.00000074	0.0000015	-0.0000001	0.0	0.0000001	0.0
29	0.00000023	0.0000014	0.0	0.0	-0.0000001	0.0
30	0.00000022	-0.0000007	0.0	0.0000001	0.0	0.0000001
31	-0.00000017	-0.0000005	-0.0000001	-0.0000001	0.0000001	0.0000001
32	-0.00000005	0.0000003	0.0	0.0	0.0	0.0
33	0.00000008	0.0000001	0.0000001	0.0	-0.0000001	0.0
SUMS	78.87204978	-20.0360776	116.3058882	61.5253607	-43.7026639	-20.6729657

DAYS 91 THRU 122 JD 2444695.5 TO 2444727.5 DATES APR 1 THRU MAY 2

A = 16.0 B = -6.68750000 W = 91

	R A	CEC	H P	X	Y	Z
TERM	H	DEG	'	E RAD	E RAD	E RAD
0	71.50606729	-5.7095523	116.2918305	39.2836467	-8.9562757	-6.3220461
1	13.94119456	-2.6885041	-0.4190407	0.2747127	-7.5017386	-2.8938990
2	-0.27484124	-4.7260987	2.5842581	52.3555355	-2.4253964	-4.7687867
3	0.25641981	16.6369761	2.0624045	3.0240229	46.6721482	17.1387996
4	0.12741543	2.0310960	-1.0737154	-27.4220807	0.5878837	2.3125595
5	-0.12470524	-3.4085561	0.0036384	0.3471532	-10.0962370	-3.7689509
6	-0.02885976	0.4457166	0.0040332	2.8967642	0.7998386	0.0701232
7	0.05631093	-0.0419771	-0.2009889	-0.6126522	0.3388943	0.1705403
8	0.00209745	-0.2331439	0.0566671	0.1343572	-0.2788337	-0.1130662
9	-0.01150148	0.1380146	0.0217912	0.0879228	0.1146445	0.0357842
10	0.00424366	0.0109364	-0.0163847	-0.0496786	-0.0035151	0.0024484
11	-0.00081805	-0.0387503	0.0083804	0.0215199	-0.0098511	-0.0052297
12	-0.00210000	0.0124022	0.0004643	-0.0020923	0.0143269	0.0054701
13	0.00136305	0.0035582	-0.0018082	-0.0065821	-0.0039695	-0.0009742
14	0.00034976	-0.0049897	0.0010696	0.0027845	-0.0013908	-0.0007253
15	-0.00050303	0.0017963	-0.0003140	-0.0002490	0.0012418	0.0004771
16	0.00010355	0.0010730	-0.0001878	-0.0004300	-0.0004821	-0.0001460
17	0.00007779	-0.0009895	0.0001669	0.0003103	-0.0000272	-0.0000327
18	-0.00009231	0.0000017	-0.0000532	-0.0000702	0.0001101	0.0000458
19	0.00002212	0.0002593	-0.0000091	-0.0000197	-0.0000598	-0.0000209
20	0.00002917	-0.0001217	0.0000206	0.0000325	0.0000123	0.0000020
21	-0.00001976	-0.0000189	-0.0000094	-0.0000142	0.0000092	0.0000045
22	-0.00000131	0.0000583	0.0000008	0.0000002	-0.0000080	-0.0000027
23	0.00000670	-0.0000202	0.0000022	0.0000035	0.0000027	0.0000006
24	-0.00000322	-0.0000127	-0.0000016	-0.0000021	0.0000008	0.0000004
25	-0.00000069	0.0000122	0.0000003	0.0000001	-0.0000011	-0.0000003
26	0.00000167	-0.0000013	0.0000002	0.0000004	0.0000001	0.0000001
27	-0.00000053	-0.0000034	-0.0000001	-0.0000002	0.0	0.0
28	-0.00000035	0.0000024	0.0000001	0.0	0.0	-0.0000001
29	0.00000036	0.0000001	0.0000001	0.0	0.0	0.0
30	-0.00000004	-0.0000012	0.0	0.0	-0.0000001	-0.0000001
31	-0.00000010	0.0000004	-0.0000001	-0.0000001	0.0	0.0
32	0.00000007	0.0000001	0.0	0.0	0.0	-0.0000001
33	0.00000001	-0.0000003	0.0	0.0000001	0.0	-0.0000001
SUMS	85.45225627	2.4291625	119.3222153	70.3348953	19.2513270	1.8623747

DAYS 121 THRU 152 JD 2444725.5 TO 2444757.5 DATES MAY 1 THRU JUNE 1

A = 16.0 B = -8.56250000 W = 121

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	'	E RAD	E RAD	E RAD
0	76.29022483	4.3829973	117.0640761	33.8370088	16.7166266	3.6039568
1	13.93433796	-2.3511275	-0.2926254	4.6772961	-5.8083500	-2.6089251
2	-0.18716569	6.6173023	3.3801965	44.8696432	26.9496513	6.6877333
3	0.34507842	16.3810355	0.9048364	-26.6086617	38.9790573	16.7484419
4	0.02137747	-3.5122897	-1.3673007	-23.1442769	-14.3629798	-3.5529960
5	-0.12167657	-2.8355699	0.1597663	5.9661151	-7.9032013	-3.4321594
6	0.08473301	0.4499945	-0.1151397	1.9275971	1.6542578	0.4605532
7	0.03802453	-0.3064601	-0.1491161	-0.2911185	-0.0263222	0.0121054
8	-0.03152081	0.1136284	0.0846792	0.2475363	0.0510337	0.0003328
9	-0.00196621	0.0937872	0.0057856	-0.0705051	0.1065733	0.0454364
10	0.00114473	-0.0965984	-0.0038497	-0.0167276	-0.0375168	-0.0126884
11	-0.00200477	0.0133845	0.0074592	0.0152902	0.0137693	0.0039969
12	0.00265455	0.0201896	-0.0032655	-0.0134523	0.0029144	0.0021394
13	-0.00007918	-0.0076707	-0.0001573	0.0005431	-0.0059929	-0.0022868
14	-0.00106710	0.0030659	0.0005050	0.0017207	0.0011053	0.0002773
15	0.00034627	-0.0001205	-0.0005510	-0.0006969	-0.0000849	0.0000219
16	0.00008486	-0.0022552	0.0001223	0.0003718	-0.0002210	-0.0001111
17	-0.00006660	0.0010516	0.0000515	0.0000122	0.0002159	0.0000796
18	0.00007657	0.0002594	-0.0000432	-0.0000772	-0.0000512	-0.0000135
19	-0.00003724	-0.0003266	0.0000275	0.0000434	-0.0000033	-0.0000045
20	-0.00002514	0.0001179	-0.0000036	-0.0000134	0.0000186	0.0000082
21	0.00002463	-0.0000248	-0.0000038	-0.0000047	-0.0000098	-0.0000033
22	-0.00000222	-0.0000420	0.0000034	0.0000042	0.0000014	0.0000001
23	-0.00000370	0.0000464	-0.0000018	-0.0000023	0.0000003	0.0000003
24	0.00000287	-0.0000056	-0.0000001	0.0000007	-0.0000014	-0.0000005
25	-0.00000193	-0.0000116	0.0000006	0.0000008	0.0000008	0.0000003
26	-0.00000011	0.0000064	-0.0000004	-0.0000005	0.0000002	0.0000001
27	0.00000109	-0.0000015	0.0000001	-0.0000001	-0.0000003	-0.0000001
28	-0.00000044	-0.0000007	-0.0000001	0.0000001	0.0	0.0
29	-0.00000011	0.0000015	-0.0000001	0.0	0.0	0.0
30	0.00000016	-0.0000010	0.0	-0.0000001	0.0	0.0
31	-0.00000010	-0.0000003	0.0	0.0000001	0.0	0.0000001
32	0.00000001	0.0000005	0.0	0.0	-0.0000001	0.0000001
33	0.00000006	-0.0000002	-0.0000001	0.0	0.0	0.0
SUMS	90.37249410	18.9643626	119.6754511	41.3976466	56.3304912	17.9558954

DAYS 152 THRU 183 JD 2444756.5 TO 2444788.5 DATES JUNE 1 THRU JULY 2

A = 16.0 B = -10.50000000 W = 152

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	°	E RAD	E RAD	E RAD
0	35.04124870	14.5373377	116.7609712	1.8585811	36.6959138	13.6964206
1	13.99496382	-0.9236592	0.0028349	7.8160214	-0.8954839	-0.9867670
2	0.11272746	17.6251269	3.0274181	8.1340446	48.7130019	17.7872901
3	0.39028861	5.8962736	-1.1629929	-49.3702674	5.7679371	6.2417087
4	-0.10395759	-8.8326822	-1.1194213	-4.4625664	-25.4851935	-9.2392148
5	0.03321608	-1.3790255	0.2236894	10.4153138	-1.6807758	-1.4943737
6	0.07087294	0.3399343	-0.1728730	0.9279782	2.4679385	0.8489406
7	-0.06604649	0.2085330	0.0187862	-0.2123397	0.3831056	0.1626716
8	-0.02303853	0.1612603	0.0788420	-0.1811315	0.1689867	0.0791365
9	0.00811432	-0.1042513	0.0008278	-0.1106996	-0.0687031	-0.0167838
10	0.00400803	0.0383924	0.0008556	0.0212970	-0.0243287	-0.0108845
11	0.00233803	0.0412112	-0.0044775	-0.0048601	0.0036572	0.0017604
12	-0.00187537	-0.0152750	-0.0025678	-0.0000140	-0.0075245	-0.0028434
13	-0.00022087	-0.0081075	0.0006934	0.0041556	0.0001904	-0.0002705
14	0.00099868	-0.0031185	-0.0000786	0.0002773	0.0011010	0.0003909
15	-0.00008437	0.0017822	0.0001114	0.0000139	0.0003239	0.0001217
16	-0.00023150	0.0016688	0.0001148	-0.0002292	0.0001967	0.0000933
17	-0.00008354	-0.0009109	-0.0000127	-0.0001318	-0.0001002	-0.0000268
18	0.00003109	-0.0001818	0.0000021	0.0000285	-0.0000404	-0.0000174
19	0.00005731	0.0002620	-0.0000113	0.0000040	0.0000007	-0.0000001
20	-0.00001712	0.0000805	-0.0000054	0.0000042	-0.0000046	-0.0000023
21	-0.00001542	-0.0000177	0.0000016	0.0000036	0.0000021	0.0000004
22	0.00000670	-0.0000673	0.0000004	0.0	0.0000013	0.0000005
23	0.00000454	-0.0000004	0.0000005	-0.0000001	0.0000006	0.0000004
24	0.00000007	0.0000231	0.0	-0.0000007	0.0	0.0
25	-0.00000230	-0.0000018	-0.0000002	0.0	-0.0000004	-0.0000002
26	-0.00000059	-0.0000049	0.0000002	0.0000003	0.0	0.0
27	0.00000089	-0.0000007	0.0	-0.0000001	0.0000001	0.0000001
28	0.00000014	0.0000014	-0.0000002	-0.0000001	0.0	0.0
29	-0.00000024	0.0000008	0.0	0.0000001	0.0	-0.0000001
30	-0.00000009	-0.0000006	-0.0000001	0.0000001	0.0	0.0000001
31	0.00000007	-0.0000004	0.0000001	0.0	0.0000001	0.0
32	0.00000005	0.0000002	0.0000002	-0.0000001	0.0	0.0
33	-0.00000001	0.0000005	0.0000001	0.0000001	0.0	0.0
SUMS	49.46330350	27.5845832	117.6527090	-25.1645170	66.0402026	27.0673513

DAYS 182 THRU 213 JD 2444786.5 TO 2444818.5 DATES JULY 1 THRU AUG 1

A = 16.0 B = -12.37500000 W = 182

	R A	CEC	H P	X	Y	Z
TERM	H	DEG	"	E RAD	E RAD	E RAD
0	39.96179624	14.7255090	115.5292160	-26.1798184	32.0946497	14.3267278
1	14.02792643	0.4779099	0.1288550	7.0948898	3.4019800	0.6854093
2	0.31288170	17.6487462	1.6463406	-23.4689566	42.7533641	18.1391719
3	0.22322829	-4.9543610	-2.0290220	-44.2511220	-22.2783782	-4.6926274
4	-0.14128592	-9.2553782	-0.5214530	12.0435321	-22.8936641	-9.6590766
5	0.05974784	0.3651736	0.3564649	10.3441271	4.2774381	0.7416346
6	-0.04115406	1.0511219	-0.1228015	-0.6610338	3.1204549	1.2332087
7	-0.07035546	0.4206187	0.0268988	-0.9019057	0.2515747	0.1717654
8	0.01466197	-0.0718391	0.0523545	-0.3135710	-0.2026214	-0.0500124
9	0.01962675	-0.0421765	0.0024221	0.0458705	-0.1461528	-0.0598568
10	0.00343210	0.0575502	-0.0056236	0.0554430	0.0135450	0.0004326
11	-0.00342363	-0.0246868	-0.0065529	-0.0052860	0.0115452	0.0047989
12	-0.00093539	-0.0286446	-0.0001505	-0.0007802	-0.0026401	-0.0009284
13	0.00094024	0.0008849	0.0013810	0.0015743	0.0005320	0.0000689
14	-0.00047832	0.0085078	0.0001624	0.0000441	0.0008319	0.0003106
15	-0.00052055	0.0024642	-0.0000481	-0.0004631	0.0003069	0.0001549
16	0.00015034	-0.0017511	-0.0000306	-0.0003085	-0.0002050	-0.0000518
17	0.00024426	-0.0002607	0.0000006	0.0000739	-0.0001695	-0.0000703
18	0.00001699	0.0004367	-0.0000010	0.0000845	0.0000161	-0.0000009
19	-0.00007160	-0.0001479	-0.0000095	0.0000037	0.0000302	0.0000111
20	-0.00000552	-0.0002379	0.0000003	-0.0000102	0.0000050	0.0000028
21	0.00001638	0.0000201	0.0000031	-0.0000034	-0.0000027	-0.0000007
22	-0.00000485	0.0001036	0.0000008	0.0000007	-0.0000014	-0.0000006
23	-0.00000729	0.0000119	-0.0000005	0.0000005	0.0000002	0.0000001
24	0.00000227	-0.0000272	-0.0000004	-0.0000001	0.0000001	0.0
25	0.00000388	-0.0000025	0.0000001	-0.0000002	0.0	0.0
26	-0.00000027	0.0000066	0.0	-0.0000001	-0.0000001	-0.0000001
27	-0.00000132	-0.0000012	-0.0000001	0.0	0.0	0.0000002
28	0.00000001	-0.0000031	0.0	0.0	0.0	0.0000002
29	0.00000034	0.0000005	0.0	-0.0000001	0.0000001	0.0
30	-0.00000003	0.0000014	-0.0000001	0.0	-0.0000001	0.0
31	-0.00000015	0.0	0.0000001	0.0	0.0	-0.0000001
32	0.00000003	-0.0000005	0.0000002	0.0	0.0	0.0
33	0.00000007	-0.0000002	0.0	0.0	0.0	0.0
SUMS	54.36643177	20.3795487	115.0584067	-66.1976152	40.4004388	20.8410719

DAYS 213 THRU 244 JD 2444817.5 TO 2444849.5 DATES AUG 1 THRU SEPT 1

A = 16.0 B = -14.31250000 W = 213

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	'	E RAD	E RAD	E RAD
0	46.45562297	5.5281225	113.4886023	-50.5493193	3.2428024	5.4668226
1	14.04114900	2.3774115	0.2016947	2.2742949	7.1560217	2.4853751
2	0.33100510	7.4550126	-0.6141607	-49.7397804	10.3898800	8.0740189
3	-0.14407233	-15.3652500	-2.0418924	-12.4918270	-44.7169904	-15.8820293
4	-0.13050892	-4.4198319	0.5278053	26.7894701	-6.1192913	-4.5766911
5	-0.01125562	3.6031538	0.3405900	3.9160382	10.7681873	3.7489029
6	-0.05913679	1.3246179	-0.1806471	-3.8555714	1.7273729	0.9816379
7	0.03208485	-0.3181444	0.0196196	-1.0118078	-1.1019381	-0.3320615
8	0.04061594	-0.2916436	0.0549520	0.3182509	-0.4545009	-0.1992305
9	-0.00602050	0.0143524	-0.0027185	0.2218115	0.0954828	0.0174190
10	-0.01322639	-0.0025650	-0.0177225	-0.0336220	0.0833555	0.0344171
11	-0.00095212	-0.0078636	-0.0028643	-0.0336736	-0.0143966	-0.0025996
12	0.00232307	0.0235032	0.0047604	0.0069019	-0.0114419	-0.0049141
13	0.00035088	0.0094249	0.0012043	0.0049368	0.0034911	0.0009046
14	0.00025603	-0.0081123	-0.0009775	-0.0019029	0.0020738	0.0009450
15	0.00024192	-0.0048323	-0.0003151	-0.0011698	-0.0009701	-0.0002688
16	-0.00029268	0.0012606	0.0001951	0.0005021	-0.0005755	-0.0002600
17	-0.00024476	0.0011917	0.0000695	0.0003342	0.0002314	0.0000593
18	0.00007833	0.0000877	-0.0000500	-0.0001042	0.0001588	0.0000689
19	0.00010426	0.0000266	-0.0000156	-0.0000862	-0.0000430	-0.0000088
20	-0.00000250	-0.0000602	0.0000145	0.0000173	-0.0000389	-0.0000162
21	-0.00002118	-0.0001513	0.0000045	0.0000201	0.0000071	0.0000009
22	-0.00000330	-0.0000218	-0.0000039	-0.0000029	0.0000088	0.0000036
23	-0.00000239	0.0000658	-0.0000015	-0.0000045	-0.0000014	-0.0000001
24	-0.00000111	0.0000235	0.0000011	0.0000007	-0.0000021	-0.0000007
25	0.00000336	-0.0000135	0.0000004	0.0000012	0.0000003	0.0000001
26	0.00000195	-0.0000078	-0.0000001	-0.0000003	0.0000004	0.0000002
27	-0.00000113	-0.0000003	-0.0000001	-0.0000003	-0.0000001	0.0
28	-0.00000099	-0.0000003	0.0	0.0000001	-0.0000001	0.0
29	0.00000010	0.0000007	0.0000001	0.0000001	0.0	0.0000001
30	0.00000024	0.0000015	0.0000001	0.0	0.0	0.0
31	0.00000007	0.0000001	0.0000001	0.0000001	0.0	0.0
32	0.00000003	-0.0000007	0.0000001	0.0	0.0	-0.0000001
33	0.0	0.0	0.0	-0.0000001	0.0	0.0000001
SUMS	60.53809539	-0.0802420	111.7781448	-84.1862925	-18.9511161	-0.1875045

DAYS 244 THRU 275 JD 2444848.5 TO 2444880.5 DATES SEPT 1 THRU OCT 2

A = 16.0 B = -16.25C00000 W = 244

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	'	E RAD	E RAD	E RAD
0	52.64609433	-7.6112970	112.0314226	-44.8427238	-32.0514006	-8.5203301
1	14.08898488	2.5660623	-0.0351901	-4.2094494	5.9982401	2.5478288
2	0.03687554	-6.9700421	-2.2543405	-42.2884564	-27.9592392	-7.2149109
3	-0.33654982	-15.4606039	-0.7239024	26.4037252	-37.1342225	-16.3770526
4	-0.04625579	3.7720010	1.2927155	23.3302284	15.1933798	3.8417023
5	0.02963819	4.4573311	-0.0448155	-6.6707105	9.7817201	4.2992892
6	0.05136560	-0.6478202	-0.2983651	-4.2425655	-2.4530935	-0.5772378
7	0.03634371	-0.9214500	0.1155133	0.8662016	-1.5495125	-0.6650034
8	-0.02683455	0.0779891	0.0769847	0.6843685	0.3292262	0.0678985
9	-0.01853038	0.1822273	-0.0428912	-0.1471847	0.2653753	0.1136594
10	0.00853996	0.0081083	-0.0224719	-0.1207114	-0.0738154	-0.0180058
11	0.00635562	-0.0233468	0.0131255	0.0405976	-0.0460003	-0.0209535
12	-0.00159579	-0.0129343	0.0059560	0.0210001	0.0213735	0.0063902
13	-0.00180919	-0.0014956	-0.0039603	-0.0120317	0.0080157	0.0040656
14	-0.00020399	0.0060878	-0.0013565	-0.0038687	-0.0061563	-0.0020245
15	0.00041007	0.0025696	0.0012016	0.0034272	-0.0014977	-0.0008582
16	0.00035103	-0.0018189	0.0002664	0.0007470	0.0017078	0.0005892
17	-0.00005092	-0.0012832	-0.0003698	-0.0009380	0.0002742	0.0001830
18	-0.00019082	0.0002571	-0.0000418	-0.0001323	-0.0004580	-0.0001639
19	-0.00001840	0.0004889	0.0001131	0.0002497	-0.0000402	-0.0000362
20	0.00007138	0.0000979	0.0000025	0.0000165	0.0001203	0.0000446
21	0.00002011	-0.0001539	-0.0000337	-0.0000655	0.0000013	0.0000060
22	-0.00001880	-0.0000992	0.0000021	0.0000012	-0.0000314	-0.0000120
23	-0.00001159	0.0000368	0.0000098	0.0000171	0.0000024	-0.0000006
24	0.00000207	0.0000503	-0.0000014	-0.0000019	0.0000081	0.0000032
25	0.00000517	-0.0000032	-0.0000028	-0.0000045	-0.0000013	-0.0000002
26	0.00000127	-0.0000187	0.0000007	0.0000009	-0.0000022	-0.0000008
27	-0.00000183	-0.0000033	0.0000007	0.0000012	0.0000006	0.0000001
28	-0.00000115	0.0000055	-0.0000003	-0.0000003	0.0000006	0.0000003
29	0.00000044	0.0000029	-0.0000002	-0.0000003	-0.0000002	-0.0000001
30	0.00000055	-0.0000009	0.0000001	0.0000001	-0.0000002	-0.0000001
31	-0.00000004	-0.0000014	0.0000002	0.0000002	0.0000001	0.0
32	-0.00000024	-0.0000001	-0.0000001	-0.0000001	-0.0000001	0.0000001
33	-0.00000003	0.0000005	0.0000001	-0.0000001	0.0	0.0000001
SUMS	66.47298659	-20.5790563	110.1095713	-51.1882626	-69.6760255	-22.5149301

DAYS 274 THRU 305 JD 2444878.5 TO 2444910.5 DATES OCT 1 THRU NOV 1

A = 16.0 B = -18.12500000 W = 274

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	'	E RAD	E RAD	E RAD
0	57.16577842	-15.3694182	111.6761099	-23.6382845	-49.1627191	-17.0425609
1	14.13284006	1.3277535	-0.3230424	-7.0777230	2.2465743	1.3463388
2	-0.17513606	-15.0782729	-2.6971498	-18.3656873	-44.9726994	-15.9103292
3	-0.31431020	-9.2308985	0.5884083	44.5762751	-15.5796473	-9.7790999
4	0.06192062	8.5584684	1.4520294	9.9815853	24.8668154	8.7553737
5	0.11894225	2.4099511	-0.4822293	-11.9322033	3.7536235	2.4700244
6	0.04487676	-1.9969574	-0.3026955	-1.5103638	-4.6057762	-1.6469277
7	-0.04596086	-0.3661083	0.2498729	1.9729505	-0.3686485	-0.3108661
8	-0.03036687	0.5131009	0.0582417	0.0937356	0.7977587	0.2996923
9	0.01812772	0.0789383	-0.0877127	-0.3864214	-0.0224723	0.0241271
10	0.01069681	-0.1450974	-0.0074171	0.0353065	-0.1684123	-0.0679678
11	-0.00647057	-0.0292650	0.0271741	0.0854105	0.0324752	0.0053042
12	-0.00372336	0.0422890	-0.0016066	-0.0229670	0.0369177	0.0161918
13	0.00195658	0.0121650	-0.0079715	-0.0186890	-0.0143260	-0.0039486
14	0.00152551	-0.0128956	0.0017675	0.0088900	-0.0077205	-0.0037320
15	-0.00051144	-0.0048757	0.0021847	0.0037719	0.0049443	0.0015890
16	-0.00067268	0.0038832	-0.0009121	-0.0029313	0.0013997	0.0007875
17	0.00012659	0.0019405	-0.0005437	-0.0006153	-0.0015443	-0.0005438
18	0.00029194	-0.0010738	0.0003756	0.0008945	-0.0001630	-0.0001379
19	-0.00002814	-0.0007934	0.0001138	0.0000401	0.0004528	0.0001714
20	-0.00012120	0.0002566	-0.0001370	-0.0002567	-0.0000213	0.0000132
21	0.00000200	0.0003334	-0.0000146	0.0000269	-0.0001249	-0.0000504
22	0.00004862	-0.0000454	0.0000456	0.0000690	0.0000247	0.0000037
23	0.00000362	-0.0001402	-0.0000025	-0.0000181	0.0000321	0.0000138
24	-0.00001924	-0.0000006	-0.0000142	-0.0000172	-0.0000120	-0.0000032
25	-0.00000342	0.0000577	0.0000031	0.0000079	-0.0000075	-0.0000035
26	0.00000759	0.0000066	0.0000040	0.0000037	0.0000047	0.0000014
27	0.00000218	-0.0000232	-0.0000016	-0.0000030	0.0000015	0.0000008
28	-0.00000295	-0.0000048	-0.0000010	-0.0000007	-0.0000017	-0.0000005
29	-0.00000117	0.0000089	0.0000007	0.0000009	-0.0000002	-0.0000002
30	0.00000112	0.0000028	0.0000003	0.0000001	0.0000006	0.0000002
31	0.00000059	-0.0000036	-0.0000002	-0.0000003	0.0	0.0000001
32	-0.00000040	-0.0000015	0.0	0.0	-0.0000001	0.0
33	-0.00000032	0.0000011	0.0000002	0.0000001	0.0	0.0
SUMS	70.97982010	-29.2867185	110.1448800	-6.1972133	-83.1632714	-31.8465383

DAYS 305 THRU 336 JD 2444909.5 TO 2444941.5 DATES NOV 1 THRU DEC 2

A = 16.0 B = -20.06250000 W = 305

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	"	E RAD	E RAD	E RAD
0	63.51859639	-18.4696645	112.2814876	15.2671902	-48.7461893	-20.4161420
1	14.13190028	-1.0074714	-0.6669878	-6.2436464	-3.6654249	-1.0100324
2	-0.31490542	-17.7446293	-2.0210230	22.9878132	-42.3017608	-18.5916880
3	-0.16271880	4.1965675	2.2008116	43.2577584	20.9153436	4.3938052
4	0.20689073	9.7277789	0.8121292	-13.1272724	22.8397636	10.0674281
5	0.10008437	-1.8539921	-0.9143546	-10.6110634	-6.3674265	-1.5447033
6	-0.10394882	-1.6548861	0.0777396	3.1489784	-3.3735346	-1.5905449
7	-0.05407159	0.8241445	0.3061668	1.0896904	1.4771176	0.4793218
8	0.04465432	0.1938670	-0.1073565	-0.7790021	0.2035415	0.1473663
9	0.01332205	-0.3465603	-0.0701683	0.0010214	-0.3599304	-0.1404100
10	-0.01713692	-0.0023131	0.0494699	0.1831984	0.0563077	0.0059693
11	-0.00045979	0.1277153	0.0069969	-0.0518408	0.0754677	0.0339660
12	0.00684817	-0.0196006	-0.0172503	-0.0342516	-0.0355221	-0.0108679
13	-0.00110347	-0.0410559	0.0029543	0.0229818	-0.0109258	-0.0062702
14	-0.00271176	0.0148779	0.0046318	0.0032854	0.0124086	0.0045532
15	0.00083876	0.0118368	-0.0023210	-0.0070669	-0.0002884	0.0005053
16	0.00097930	-0.0078585	-0.0008183	0.0009938	-0.0033080	-0.0013761
17	-0.00051175	-0.0030353	0.0009881	0.0016872	0.0009842	0.0002360
18	-0.00031259	0.0035052	-0.0000233	-0.0007479	0.0006601	0.0003222
19	0.00027610	0.0005772	-0.0003130	-0.0002750	-0.0004657	-0.0001572
20	0.00008310	-0.0014411	0.0000995	0.0002932	-0.0000619	-0.0000497
21	-0.00013373	0.0000157	0.0000729	-0.0000006	0.0001532	0.0000596
22	-0.00001229	0.0005659	-0.0000539	-0.0000860	-0.0000240	-0.0000017
23	0.00005968	-0.0001006	-0.0000081	0.0000236	-0.0000385	-0.0000171
24	-0.00000532	-0.0002124	0.0000199	0.0000189	0.0000176	0.0000052
25	-0.00002490	0.0000756	-0.0000033	-0.0000122	0.0000065	0.0000037
26	0.00000685	0.0000748	-0.0000056	-0.0000022	-0.0000069	-0.0000026
27	0.00000966	-0.0000434	0.0000028	0.0000043	0.0	-0.0000004
28	-0.00000475	-0.0000240	0.0000009	-0.0000006	0.0000021	0.0000009
29	-0.00000337	0.0000222	-0.0000011	-0.0000011	-0.0000006	-0.0000001
30	0.00000273	0.0000064	0.0	0.0000005	-0.0000004	-0.0000001
31	0.00000101	-0.0000107	0.0000005	0.0000003	0.0000003	0.0000001
32	-0.00000137	-0.0000011	-0.0000003	-0.0000002	0.0000001	0.0
33	-0.00000022	0.0000048	-0.0000001	-0.0000001	-0.0000001	0.0
SUMS	77.36648664	-26.0512647	111.9428838	55.1096699	-59.2831345	-28.1787208

DAYS 335 THRU 366 JD 2444939.5 TO 2444971.5 DATES DEC 1 THRU JAN 1

A = 16.0 B = -21.93750000 W = 335

	R A	DEC	H P	X	Y	Z
TERM	H	DEG	'	E RAD	E RAD	E RAD
0	68.19844357	-13.8584666	113.2846672	38.4121630	-30.6576675	-15.5335289
1	14.08971039	-2.2139518	-0.7024347	-2.7475088	-6.1082932	-2.2146621
2	-0.33364366	-12.2705149	-0.9497439	45.5293067	-21.6818396	-12.6707774
3	-0.07981292	13.1084466	2.7028595	23.5282470	40.2066095	13.6533951
4	0.23976660	6.3019855	0.1107173	-25.0000738	11.1104056	6.6320697
5	-0.02960251	-3.9055395	-0.9353646	-4.5922021	-10.5443165	-3.7129408
6	-0.14947608	-0.3772585	0.3035302	4.3836851	-0.6142018	-0.6388786
7	0.03702924	0.8518078	0.2206107	-0.3184771	1.4926478	0.6132336
8	0.05448984	-0.3677712	-0.1615504	-0.5713690	-0.4249927	-0.1149057
9	-0.02166676	-0.1829583	-0.0170426	0.3068487	-0.1579402	-0.0897112
10	-0.00894639	0.2249533	0.0507423	0.0356492	0.1665126	0.0620874
11	0.01088503	0.0130081	-0.0139354	-0.0911970	-0.0124499	0.0033810
12	-0.00162256	-0.0847593	-0.0106289	0.0189447	-0.0392775	-0.0171244
13	-0.00453760	0.0200769	0.0083727	0.0177209	0.0153016	0.0043960
14	0.00221211	0.0221249	0.0004271	-0.0104645	0.0053402	0.0030430
15	0.00132070	-0.0158912	-0.0028089	-0.0012198	-0.0057518	-0.0021451
16	-0.00127584	-0.0026605	0.0008509	0.0032255	0.0005081	-0.0000932
17	-0.00009843	0.0075118	0.0005855	-0.0007686	0.0014156	0.0006244
18	0.00055474	-0.0014090	-0.0004787	-0.0006457	-0.0006269	-0.0001870
19	-0.00017354	-0.0025447	-0.0000136	0.0004383	-0.0001898	-0.0001141
20	-0.00018273	0.0013872	0.0001584	0.0000364	0.0002439	0.0000920
21	0.00014355	0.0005311	-0.0000532	-0.0001391	-0.0000281	0.0000016
22	0.00003191	-0.0007480	-0.0000320	0.0000367	-0.0000614	-0.0000273
23	-0.00007338	0.0000476	0.0000289	0.0000284	0.0000293	0.0000087
24	0.00001182	0.0002971	0.0000001	-0.0000204	0.0000083	0.0000050
25	0.00002772	-0.0001231	-0.0000093	-0.0000016	-0.0000113	-0.0000043
26	-0.00001540	-0.0000829	0.0000033	0.0000065	0.0000014	0.0
27	-0.00000680	0.0000801	0.0000019	-0.0000017	0.0000028	0.0000013
28	0.00000940	0.0000072	-0.0000017	-0.0000013	-0.0000013	-0.0000003
29	-0.00000031	-0.0000365	-0.0000001	0.0000009	-0.0000004	-0.0000002
30	-0.00000409	0.0000098	0.0000006	0.0000001	0.0000005	0.0000001
31	0.00000161	0.0000122	-0.0000003	-0.0000003	-0.0000001	0.0
32	0.00000126	-0.0000085	-0.0000002	0.0000001	-0.0000002	0.0
33	-0.00000117	-0.0000023	0.0000001	0.0000001	0.0000001	0.0
SUMS	82.00349932	-12.7324396	113.8894582	78.9022475	-17.2486229	-14.0227617

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1981
MERCURY AND VENUS

DAYS 1 THRU 95 JD 2444605.5 TO 2444700.5 DATES JAN 1 THRU APR 5

A = 47.5 B = -1.02105263 W = 1

TERM	MERCURY R A H	MERCURY DEC DEG	MERCURY DISTANCE AU	VENUS R A H	VENUS DEC DEG	VENUS DISTANCE AU
0	43.1421782	-27.912721	2.1837176	42.2995661	-25.160229	3.2825970
1	1.9341028	8.501274	-0.1688131	3.9662817	14.238389	0.1072237
2	-0.3275393	-2.222706	0.3010313	-0.1258162	4.195919	-0.0222243
3	0.7785418	2.949017	0.0534361	-0.0032519	-0.758783	-0.0005239
4	0.0749615	2.401123	-0.0982058	0.0133164	-0.072819	-0.0001019
5	-0.2789330	-1.403062	-0.0017282	-0.0006967	0.023175	-0.0000008
6	-0.0091897	-0.659856	0.0321455	-0.0005457	-0.002486	0.0000035
7	0.1122163	0.631713	-0.0039137	0.0001650	-0.000632	0.0000028
8	-0.0027043	0.181419	-0.0111034	0.0000147	0.000243	-0.0000195
9	-0.0465416	-0.281847	0.0028940	-0.0000525	-0.000099	-0.0000031
10	0.0040684	-0.045858	0.0036987	-0.0000018	-0.000079	0.0000120
11	0.0195772	0.124574	-0.0015460	0.0000172	0.000043	0.0000010
12	-0.0029172	0.008680	-0.0011781	0.0000012	0.000032	-0.0000036
13	-0.0082799	-0.054758	0.0007066	-0.0000042	-0.000010	-0.0000005
14	0.0017037	0.000034	0.0003547	0.0000003	-0.000002	0.0000006
15	0.0035246	0.024091	-0.0002911	0.0000012	-0.000001	0.0000002
16	-0.0009017	-0.001252	-0.0001025	-0.0000010	0.000004	0.0
17	-0.0015158	-0.010712	0.0001104	0.0000003	-0.000001	0.0000002
18	0.0004509	0.000924	0.0000307	0.0	-0.000007	0.0
19	0.0006625	0.004857	-0.0000392	-0.0000006	0.000004	-0.0000004
20	-0.0002193	-0.000520	-0.0000112	0.0000008	0.000007	0.0
21	-0.0002957	-0.002261	0.0000133	0.0000006	-0.000003	0.0000002
22	0.0001057	0.000269	0.0000055	-0.0000005	-0.000004	0.0
23	0.0001348	0.001077	-0.0000045	-0.0000006	-0.000001	-0.0000001
24	-0.0000513	-0.000141	-0.0000032	0.0000001	0.000002	0.0
25	-0.0000627	-0.000526	0.0000017	0.0000002	0.000002	0.0
26	0.0000254	0.000075	0.0000019	-0.0000001	0.0	0.0
27	0.0000297	0.000260	-0.0000008	-0.0000001	0.000001	0.0
28	-0.0000124	-0.000040	-0.0000011	0.0000003	0.0	0.0
29	-0.0000144	-0.000129	0.0000004	-0.0000001	-0.000001	0.0
30	0.0000063	0.000026	0.0000006	-0.0000002	-0.000002	0.0
31	0.0000068	0.000068	-0.0000003	0.0000004	0.0	0.0
32	-0.0000034	-0.000015	-0.0000003	0.0	0.0	0.0
33	-0.0000032	-0.000033	0.0000001	-0.0000002	-0.000001	0.0
SUMS	45.3931117	-17.766956	2.2912066	46.1489941	-7.537339	3.3669631

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1981
MERCURY AND VENUS

DAYS 91 THRU 185 JD 2444695.5 TO 2444790.5 DATES APR 1 THRU JULY 4

A = 47.5 B = -2.91578947 W = 91

TERM	MERCURY R A H	MERCURY DEC DEG	MERCURY DISTANCE AU	VENUS R A H	VENUS DEC DEG	VENUS DISTANCE AU
0	55.2412937	26.814488	1.8841559	9.0657677	32.992552	3.3137558
1	3.4908925	12.392160	-0.3798480	4.0207442	9.383469	-0.0980598
2	-1.2762490	-9.289585	-0.0560321	0.0910881	-5.223730	-0.0315201
3	-0.3974478	0.693882	0.1660375	-0.0295593	-0.559704	-0.0001889
4	0.2011977	2.230059	0.0181188	-0.0126879	0.127166	0.0002455
5	0.1199139	-0.228712	-0.0248832	0.0013954	0.024159	0.0000185
6	-0.0018815	-0.289637	0.0041998	0.0008474	-0.001451	-0.0000030
7	-0.0030886	0.138243	0.0043569	0.0000575	-0.001410	0.0000038
8	0.0009204	0.017598	-0.0038797	-0.0000382	0.000011	-0.0000193
9	-0.0067528	-0.065770	-0.0005144	-0.0000496	-0.000034	-0.0000048
10	-0.0024092	0.005768	0.0015423	-0.0000067	0.000016	0.0000115
11	0.0022301	0.017684	-0.0002125	0.0000169	0.000066	0.0000020
12	0.0006932	-0.006631	-0.0004226	0.0000025	-0.000008	-0.0000036
13	-0.0004056	-0.002423	0.0002213	-0.0000048	-0.000014	-0.0000005
14	0.0001178	0.003996	0.0000677	-0.0000026	-0.000001	0.0000010
15	0.0000816	-0.000395	-0.0001140	0.0000009	0.000001	0.0000001
16	-0.0001527	-0.001542	0.0000127	0.0000007	-0.000006	0.0000001
17	-0.0000180	0.000530	0.0000405	0.0000013	-0.000008	0.0000001
18	0.0000626	0.000358	-0.0000186	0.0000014	0.000008	-0.0000005
19	-0.0000081	-0.000315	-0.0000092	-0.0000014	0.000003	-0.0000001
20	-0.0000176	-0.000007	0.0000108	-0.0000018	-0.000003	0.0000004
21	0.0000111	0.000138	-0.0000001	0.0000007	-0.000003	0.0000001
22	0.0000040	-0.000046	-0.0000044	0.0000011	0.000003	-0.0000002
23	-0.0000059	-0.000039	0.0000015	-0.0000005	0.000002	0.0
24	-0.0000003	0.000031	0.0000012	-0.0000006	-0.000001	0.0000001
25	0.0000020	0.000004	-0.0000010	0.0000001	-0.000001	0.0
26	-0.0000008	-0.000015	-0.0000001	0.0000002	-0.000002	0.0
27	-0.0000001	0.000003	0.0000005	-0.0000002	0.000001	0.0
28	0.0000008	0.000006	-0.0000002	0.0000003	0.000001	0.0
29	-0.0000002	-0.000005	-0.0000002	0.0000001	0.000003	0.0
30	-0.0000005	-0.000001	0.0000001	-0.0000003	0.0	0.0
31	0.0000001	-0.000002	0.0	0.0000002	-0.000002	0.0
32	0.0000003	-0.000001	-0.0000001	0.0000004	0.0	0.0
33	-0.0000002	-0.000001	0.0	-0.0000001	0.000002	0.0
SUMS	57.3689829	32.429821	1.6128271	13.1375731	36.741085	3.1842382

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1981
MERCURY AND VENUS

DAYS 182 THRU 276 JD 2444786.5 TO 2444881.5 DATES JULY 1 THRU OCT 3

A = 47.5 B = -4.83157895 W = 182

TERM	MERCURY R A H	MERCURY DEC DEG	MERCURY DISTANCE AU	VENUS R A H	VENUS DEC DEG	VENUS DISTANCE AU
0	19.8203054	11.900218	1.9867018	23.7905264	1.581959	2.5333676
1	4.6090813	-20.116892	0.1023616	3.5423610	-21.908571	-0.2978310
2	-0.1594052	-5.729510	-0.3233519	-0.0479443	-0.491905	-0.0169347
3	-0.4693825	3.336575	0.0093545	0.0404934	0.852072	0.0018837
4	0.1749799	0.994218	0.0430782	0.0007102	-0.005204	-0.0000506
5	-0.0280941	-0.746202	-0.0227345	-0.0016407	0.001473	-0.0000120
6	-0.0487011	0.213761	-0.0004748	0.0000360	0.000509	0.0000036
7	0.0153338	0.152107	0.0072811	0.0000049	-0.000785	0.0000018
8	0.0051964	-0.097287	-0.0020600	-0.0000016	-0.000062	-0.0000196
9	-0.0072074	-0.000726	-0.0013392	-0.0000480	0.000246	-0.0000023
10	0.0006820	0.032339	0.0012858	-0.0000070	0.000092	0.0000125
11	0.0022752	-0.011510	-0.0000237	0.0000213	-0.000102	0.0000013
12	-0.0011391	-0.006507	-0.0004336	0.0000028	-0.000035	-0.0000038
13	-0.0003148	0.006646	0.0001871	-0.0000039	0.000014	0.0
14	0.0005554	-0.000434	0.0000801	0.0000009	0.000001	0.0000006
15	-0.0001117	-0.002272	-0.0001022	-0.0000009	-0.000001	-0.0000002
16	-0.0001581	0.001096	0.0000125	-0.0000004	-0.000002	-0.0000001
17	0.0001073	0.000398	0.0000332	-0.0000007	0.000008	-0.0000002
18	0.0000141	-0.000578	-0.0000187	-0.0000008	0.000008	0.0000001
19	-0.0000462	0.000086	-0.0000047	0.0000018	-0.000011	0.0000003
20	0.0000159	0.000181	0.0000093	0.0000016	-0.000011	-0.0000001
21	0.0000110	-0.000110	-0.0000023	-0.0000013	0.000005	-0.0000002
22	-0.0000118	-0.000023	-0.0000028	-0.0000009	0.000004	0.0
23	0.0000005	0.000053	0.0000021	0.0000007	-0.000002	0.0000001
24	0.0000046	-0.000015	0.0000002	0.0000001	0.0	0.0
25	-0.0000020	-0.000016	-0.0000009	-0.0000003	-0.000002	0.0
26	-0.0000007	0.000014	0.0000003	-0.0000002	-0.000001	0.0
27	0.0000012	0.000002	0.0000002	0.0000002	0.000001	0.0
28	-0.0000002	-0.000006	-0.0000002	0.0000001	0.000002	0.0
29	-0.0000004	0.000001	0.0	-0.0000001	0.000001	0.0
30	0.0	0.000004	0.0000001	-0.0000001	0.000001	0.0
31	0.0	-0.000002	-0.0000001	0.0000001	0.000002	0.0
32	0.0	-0.000001	0.0	0.0000001	0.0	0.0
33	0.0000001	-0.000001	0.0	-0.0000002	-0.000001	0.0
SUMS	23.9139888	-10.074393	1.7998385	27.3245102	-19.970297	2.2204168

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1981
MERCURY AND VENUS

DAYS 274 THRU 368 JD 2444878.5 TO 2444973.5 DATES OCT 1 THRU JAN 3

A = 47.5 B = -6.76842105 W = 274

TERM	MERCURY R A H	MERCURY DEC DEG	MERCURY DISTANCE AU	VENUS R A H	VENUS DEC DEG	VENUS DISTANCE AU
0	31.7871280	-35.063941	2.2178460	36.8726334	-43.694670	1.2559247
1	3.1846559	-6.428661	0.3548062	2.9071303	2.612982	-0.3416899
2	1.2369103	-3.258149	-0.0984405	-0.4706817	4.258903	0.0110517
3	-0.3103621	4.371720	-0.1632168	-0.1550292	-0.730647	0.0062239
4	-0.1149674	1.301636	0.0676616	-0.0164034	-0.224791	0.0016350
5	0.1800227	-1.876915	-0.0013315	-0.0010115	0.007139	0.0003974
6	-0.0961398	0.766784	-0.0232847	-0.0004261	0.003281	0.0000760
7	-0.0074993	0.198439	0.0134588	0.0004430	-0.000972	0.0000051
8	0.0421017	-0.447171	-0.0001788	0.0002158	-0.000057	-0.0000189
9	-0.0267136	0.225220	-0.0045738	-0.0000493	0.000181	0.0000060
10	0.0016900	0.025375	0.0028673	0.0000336	-0.000017	0.0000122
11	0.0095355	-0.111674	-0.0001064	0.0000628	0.000021	-0.0000033
12	-0.0074090	0.068797	-0.0009669	0.0000041	0.000059	-0.0000042
13	0.0013511	-0.002470	0.0006371	-0.0000148	-0.000001	0.0000002
14	0.0020489	-0.027300	-0.0000453	-0.0000040	-0.000015	0.0000008
15	-0.0020024	0.020956	-0.0002010	0.0000016	-0.000013	0.0000002
16	0.0005931	-0.003765	0.0001427	-0.0000011	-0.000001	-0.0000001
17	0.0003911	-0.006195	-0.0000178	0.0000010	0.000002	0.0000003
18	-0.0005227	0.006236	-0.0000395	0.0000024	-0.000004	0.0000001
19	0.0002163	-0.001994	0.0000310	-0.0000005	0.000005	-0.0000005
20	0.0000557	-0.001187	-0.0000063	-0.0000014	0.000005	-0.0000001
21	-0.0001280	0.001772	-0.0000063	-0.0000002	-0.000008	0.0000003
22	0.0000719	-0.000845	0.0000064	0.0000003	-0.000004	0.0000001
23	-0.0000013	-0.000129	-0.0000023	0.0000001	0.000001	-0.0000001
24	-0.0000292	0.000482	-0.0000006	0.0	0.000005	0.0
25	0.0000227	-0.000315	0.0000012	0.0000003	0.000001	0.0
26	-0.0000048	0.000031	-0.0000007	0.0	0.000001	0.0
27	-0.0000059	0.000117	0.0000002	-0.0000003	0.000003	0.0
28	0.0000069	-0.000111	0.0000002	0.0	-0.000001	0.0
29	-0.0000028	0.000031	-0.0000002	0.0000001	0.000001	0.0
30	-0.0000012	0.000028	0.0000001	0.0000001	0.0	0.0
31	0.0000022	-0.000035	0.0	0.0	0.0	0.0
32	-0.0000009	0.000015	0.0	0.0000002	-0.000003	0.0
33	0.0	0.000004	0.0000001	-0.0000001	-0.000001	0.0
SUMS	35.8810136	-40.243214	2.3650395	39.1369055	-37.768615	0.9336169

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1981
MARS AND JUPITER

DAYS 1 THRU 95 JD 2444605.5 TO 2444700.5 DATES JAN 1 THRU APR 5

A = 47.5 B = -1.02105263 W = 1

TERM	MARS R A (H)	MARS DEC (DEG)	MARS DISTANCE (AU)	JUPITER R A (H)	JUPITER DEC (DEG)	JUPITER DISTANCE (AU)
0	45.2772097	-17.154066	4.6857348	25.0714658	-3.710968	9.5666725
1	2.3626671	13.529862	0.0706447	-0.1726492	1.273887	-0.4508579
2	-0.0500575	0.779278	-0.0044779	-0.0833761	0.502106	0.1208498
3	0.0066885	-0.252999	-0.0001772	0.0113044	-0.079996	0.0167062
4	0.0012071	0.001627	-0.0001238	0.0029259	-0.018397	-0.0017914
5	-0.0002266	0.001616	0.0000091	-0.0000522	0.000393	-0.0003806
6	0.0000098	-0.000220	-0.0000030	-0.0000928	0.000609	0.0000103
7	0.0000153	0.000107	0.0000056	-0.0000084	0.000060	0.0000067
8	0.0000159	0.000070	-0.0000158	-0.0000078	0.000044	0.0000071
9	-0.0000266	-0.000102	-0.0000101	0.0000068	-0.000027	0.0000170
10	-0.0000116	-0.000075	0.0000121	0.0000109	-0.000066	-0.0000080
11	0.0000125	0.000041	0.0000044	-0.0000048	0.000021	-0.0000109
12	0.0000042	0.000033	-0.0000041	-0.0000042	0.000025	0.0000035
13	-0.0000032	-0.000013	-0.0000014	0.0000011	-0.000004	0.0000036
14	-0.0000001	-0.000003	0.0000007	0.0000024	-0.000013	-0.0000006
15	0.0000010	0.0	0.0000004	0.0000005	-0.000005	-0.0000009
16	-0.0000005	0.000004	0.0	-0.0000008	0.000005	-0.0000001
17	0.0	0.000002	0.0000001	0.0000003	-0.000002	0.0
18	-0.0000004	-0.000003	0.0000001	-0.0000010	0.000005	-0.0000002
19	-0.0000004	0.000001	-0.0000003	-0.0000008	0.000006	0.0000002
SUMS	47.5975042	-3.094840	4.7515984	24.8295200	-2.032317	9.2512263

DAYS 91 THRU 185 JD 2444695.5 TO 2444790.5 DATES APR 1 THRU JULY 4

A = 47.5 B = -2.91578947 W = 91

TERM	MARS R A (H)	MARS DEC (DEG)	MARS DISTANCE (AU)	JUPITER R A (H)	JUPITER DEC (DEG)	JUPITER DISTANCE (AU)
0	6.0182564	30.474098	4.8403507	24.3397096	0.965537	9.8340415
1	2.3071677	9.888686	0.0026104	-0.0757683	0.314905	0.5619882
2	0.0225596	-1.543935	-0.0156473	0.0932639	-0.625062	0.0832541
3	-0.0005451	-0.132971	-0.0015066	0.0037995	-0.016360	-0.0186411
4	-0.0016014	0.013492	-0.0000109	-0.0024146	0.015336	-0.0003023
5	-0.0000041	0.001093	0.0000059	0.0002154	-0.001598	0.0002866
6	0.0000244	0.000022	-0.0000055	0.0000381	-0.000184	-0.0000217
7	0.0000188	0.000059	-0.0000010	-0.0000117	0.000079	0.0000001
8	-0.0000031	0.000032	-0.0000188	0.0000094	-0.000051	0.0000103
9	-0.0000312	-0.000134	0.0000018	0.0000084	-0.000057	-0.0000153
10	0.0000023	0.000002	0.0000141	-0.0000098	0.000049	-0.0000107
11	0.0000140	0.000073	-0.0000008	-0.0000048	0.000032	0.0000093
12	-0.0000016	-0.000005	-0.0000049	0.0000034	-0.000015	0.0000044
13	-0.0000045	-0.000017	0.0000002	0.0000014	-0.000010	-0.0000032
14	-0.0000011	-0.000006	0.0000014	-0.0000026	0.000015	-0.0000013
15	0.0000012	0.000002	-0.0000001	-0.0000002	0.000002	0.0000009
16	0.0000009	-0.000001	-0.0000001	0.0000009	-0.000005	0.0000002
17	0.0000006	-0.000001	0.0	0.0	0.0	0.0000001
18	0.0000011	0.000007	-0.0000004	0.0000014	-0.000009	0.0000002
19	-0.0000013	0.000004	0.0000001	0.0	0.0	-0.0000004
SUMS	8.3458536	38.700500	4.8257882	24.3588394	0.652604	10.4605999

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1981
MARS AND JUPITER

DAYS 182 THRU 276 JD 2444786.5 TO 2444881.5 DATES JULY 1 THRU OCT 3

A = 47.5 B = -4.83157895 W = 182

TERM	MARS R A (H)	MARS DEC (DEG)	MARS DISTANCE (AU)	JUPITER R A (H)	JUPITER DEC (DEG)	JUPITER DISTANCE (AU)
0	14.7713316	42.367868	4.5238081	25.2428808	-5.431927	12.0897864
1	2.1932353	-3.680530	-0.1792571	0.5075531	-3.346285	0.4881967
2	-0.0626875	-1.548674	-0.0305551	0.0449153	-0.242016	-0.0840421
3	-0.0064309	0.124930	-0.0007609	-0.0059846	0.045577	-0.0084825
4	0.0011552	0.010014	0.0001258	0.0001561	-0.000682	0.0007999
5	0.0000425	-0.001562	-0.0000059	0.0000003	-0.000048	-0.0000056
6	-0.0000407	-0.000011	-0.0000024	-0.0000046	0.000008	-0.0000076
7	0.0000083	0.000078	-0.0000081	0.0000031	-0.000016	0.0000016
8	-0.0000300	0.000037	-0.0000081	0.0000021	-0.000019	-0.0000151
9	-0.0000154	0.000005	0.0000169	-0.0000098	0.000053	-0.0000058
10	0.0000236	-0.000013	0.0000071	-0.0000023	0.000024	0.0000158
11	0.0000100	-0.000030	-0.0000083	0.0000073	-0.000040	0.0000037
12	-0.0000077	-0.000003	-0.0000026	0.0000011	-0.000011	-0.0000064
13	-0.0000018	0.000005	0.0000022	-0.0000018	0.000009	-0.0000010
14	0.0000027	0.000009	0.0000002	0.0000004	-0.000003	0.0000015
15	-0.0000013	0.000005	-0.0000004	-0.0000008	0.000005	-0.0000001
16	-0.0000006	0.000001	0.0	-0.0000003	0.000002	-0.0000002
17	-0.0000006	0.000003	0.0	-0.0000003	0.000002	-0.0000001
18	-0.0000005	-0.000007	0.0000003	-0.0000005	0.000005	0.0000001
19	0.0000018	-0.000007	0.0	0.0000014	-0.000008	0.0000003
SUMS	16.8965940	37.272118	4.3133517	25.7895160	-8.975370	12.4862395

DAYS 274 THRU 368 JD 2444878.5 TO 2444973.5 DATES OCT 1 THRU JAN 3

A = 47.5 B = -6.76842105 W = 274

TERM	MARS R A (H)	MARS DEC (DEG)	MARS DISTANCE (AU)	JUPITER R A (H)	JUPITER DEC (DEG)	JUPITER DISTANCE (AU)
0	22.1377302	15.118947	3.3764069	27.4816034	-19.051896	12.4077154
1	1.5942892	-9.014294	-0.4073671	0.5955054	-3.315631	-0.3429193
2	-0.0879056	0.209909	-0.0227823	-0.0240826	0.235708	-0.1078688
3	-0.0048353	0.156583	0.0025687	-0.0071078	0.036767	0.0051353
4	-0.0015934	0.000833	0.0003196	-0.0003007	-0.000723	0.0010819
5	-0.0002668	0.000568	0.0000058	-0.0000111	-0.000059	0.0000083
6	-0.0000293	0.000152	0.0000069	-0.0000026	0.000031	-0.0000005
7	-0.0000181	0.000110	-0.0000050	-0.0000005	0.0	-0.0000045
8	-0.0000237	0.000133	0.0000134	-0.0000095	0.000053	0.0000016
9	0.0000312	-0.000143	0.0000128	0.0000010	0.000008	0.0000192
10	0.0000221	-0.000133	-0.0000118	0.0000087	-0.000050	-0.0000019
11	-0.0000161	0.000061	-0.0000065	-0.0000014	0.000005	-0.0000114
12	-0.0000079	0.000053	0.0000042	-0.0000028	0.000018	0.0000008
13	0.0000029	-0.000007	0.0000019	0.0	0.000003	0.0000033
14	0.0000030	-0.000022	-0.0000005	0.0000016	-0.000007	0.0000002
15	0.0000008	-0.000004	-0.0000004	0.0000008	-0.000008	-0.0000005
16	-0.0000008	0.000001	0.0000001	-0.0000007	0.000002	-0.0000001
17	0.0000005	-0.000005	-0.0000001	0.0000003	-0.000003	0.0000002
18	-0.0000013	0.000010	-0.0000004	-0.0000009	0.000003	-0.0000004
19	-0.0000019	0.000010	0.0000002	-0.0000010	0.000010	-0.0000002
SUMS	23.6373797	6.472762	2.9491664	28.0455996	-22.095769	11.9631586

SATURN AND URANUS

DAYS 1 THRU 95 JD 2444605.5 TO 2444700.5 DATES JAN 1 THRU APR 5

A = 47.5 B = -1.02105263 W = 1

TERM	SATURN R A H	SATURN DEC DEG	SATURN DISTANCE AU	URANUS R A H	URANUS DEC DEG	URANUS DISTANCE AU
0	25.1477004	-1.906233	17.7926706	31.6489046	-39.652259	37.5805458
1	-0.1197234	0.939929	-0.4599458	0.0443918	-0.137242	-0.7413314
2	-0.0444152	0.251288	0.1241964	-0.0331238	0.103392	-0.0026796
3	0.0066109	-0.048717	0.0159658	-0.0006572	0.000776	0.0218348
4	0.0011617	-0.006962	-0.0019603	0.0004858	-0.001159	0.0002139
5	-0.0000680	0.000546	-0.0002700	0.0000251	-0.000053	-0.0002127
6	-0.0000295	0.000189	0.0000208	-0.0000057	0.000003	-0.0000098
7	-0.0000010	0.000004	0.0000026	-0.0000004	0.0	-0.0000014
8	-0.0000050	0.000028	0.0000064	-0.0000034	0.000007	-0.0000060
9	0.0000030	-0.000012	0.0000172	-0.0000023	0.000017	0.0000179
10	0.0000054	-0.000032	-0.0000080	0.0000024	-0.000006	0.0000069
11	-0.0000028	0.000015	-0.0000108	0.0000005	0.000001	-0.0000110
12	-0.0000017	0.000010	0.0000036	-0.0000002	0.000003	-0.0000028
13	0.0000006	-0.000003	0.0000036	-0.0000004	0.000003	0.0000036
SUMS	24.9912354	-0.769950	17.4706921	31.6600168	-39.686517	36.8583682

DAYS 91 THRU 185 JD 2444695.5 TO 2444790.5 DATES APR 1 THRU JULY 4

A = 47.5 B = -2.91578947 W = 91

TERM	SATURN R A H	SATURN DEC DEG	SATURN DISTANCE AU	URANUS R A H	URANUS DEC DEG	URANUS DISTANCE AU
0	24.6358005	1.414286	18.0763364	31.4567893	-39.045064	35.9248600
1	-0.0782542	0.354460	0.5841279	-0.1211989	0.384015	-0.0110953
2	0.0496240	-0.345691	0.0917338	-0.0005066	0.004226	0.1581639
3	0.0036767	-0.016985	-0.0182975	0.0051228	-0.016498	-0.0001042
4	-0.0011123	0.007296	-0.0007914	-0.0000303	-0.000284	-0.0024003
5	0.0000290	-0.000321	0.0002481	-0.0000666	0.000218	0.0000223
6	0.0000200	-0.000112	-0.0000025	0.0000022	0.000010	0.0000311
7	-0.0000027	0.000020	-0.0000005	0.0000005	-0.000004	-0.0000006
8	0.0000050	-0.000028	0.0000101	0.0000006	0.000001	0.0000143
9	0.0000044	-0.000028	-0.0000147	0.0000032	-0.000017	0.0000019
10	-0.0000048	0.000025	-0.0000113	0.0000007	-0.000007	-0.0000170
11	-0.0000028	0.000017	0.0000090	-0.0000024	0.0	-0.0000013
12	0.0000012	-0.000005	0.0000047	-0.0000014	0.000007	0.0000072
13	0.0000008	-0.000005	-0.0000031	0.0000007	-0.000003	0.0000004
SUMS	24.6097848	1.412929	18.7333490	31.3401138	-38.673400	36.0694824

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1981
SATURN AND URANUS

DAYS 182 THRU 276 JD 2444786.5 TO 2444881.5 DATES JULY 1 THRU OCT 3

A = 47.5 B = -4.83157895 W = 182

TERM	SATURN R A H	SATURN DEC DEG	SATURN DISTANCE AU	URANUS R A H	URANUS DEC DEG	URANUS DISTANCE AU
0	25.0486046	-1.808670	20.4376141	31.2449154	-38.402335	37.5567449
1	0.2778174	-1.890330	0.5021522	0.0353369	-0.134566	0.7440289
2	0.0303677	-0.163534	-0.0991963	0.0316945	-0.106364	0.0050829
3	-0.0043613	0.031259	-0.0107537	-0.0003504	0.002182	-0.0201470
4	-0.0000922	0.000419	0.0010821	-0.0003968	0.001667	0.0001090
5	0.0000173	-0.000110	0.0000270	0.0000190	-0.000081	0.0001546
6	-0.0000033	0.000014	-0.0000108	0.0000022	-0.000011	-0.0000095
7	0.0000016	-0.000009	0.0000014	0.0	0.000001	0.0000022
8	0.0000007	-0.000006	-0.0000148	0.0000020	-0.000004	-0.0000065
9	-0.0000053	0.000029	-0.0000052	-0.0000003	-0.000001	-0.0000174
10	-0.0000012	0.000012	0.0000163	-0.0000030	0.000014	0.0000075
11	0.0000047	-0.000027	0.0000035	0.0000020	-0.000002	0.0000111
12	0.0000007	-0.000007	-0.0000067	0.0000014	-0.000011	-0.0000029
13	-0.0000011	0.000005	-0.0000009	-0.0000002	0.0	-0.0000034
SUMS	25.3523503	-3.830955	20.8309082	31.3112227	-38.639511	38.2859544

DAYS 274 THRU 368 JD 2444878.5 TO 2444973.5 DATES OCT 1 THRU JAN 3

A = 47.5 B = -6.76842105 W = 274

TERM	SATURN R A H	SATURN DEC DEG	SATURN DISTANCE AU	URANUS R A H	URANUS DEC DEG	URANUS DISTANCE AU
0	26.2506770	-9.350617	20.5617555	31.7287012	-39.979313	39.3575193
1	0.2984943	-1.715196	-0.4481948	0.1916853	-0.590715	0.0632518
2	-0.0267554	0.206829	-0.1114406	0.0028739	0.004880	-0.1498988
3	-0.0053345	0.029749	0.0098391	-0.0038182	0.011966	-0.0021196
4	0.0000151	-0.000920	0.0015252	-0.0000640	-0.000324	0.0019215
5	0.0000269	-0.000170	-0.0000202	0.0000193	-0.000081	0.0000227
6	0.0000003	0.000006	-0.0000043	-0.0000020	0.000009	-0.0000128
7	-0.0000004	0.000002	-0.0000038	0.0	-0.000001	-0.0000029
8	-0.0000053	0.000031	0.0000042	-0.0000030	0.000005	-0.0000067
9	0.0000015	-0.000003	0.0000186	-0.0000021	0.000014	0.0000170
10	0.0000048	-0.000029	-0.0000049	0.0000021	-0.000006	0.0000075
11	-0.0000019	0.000010	-0.0000113	0.0000003	0.000002	-0.0000110
12	-0.0000014	0.000010	0.0000021	-0.0000002	0.000004	-0.0000031
13	0.0000002	0.0	0.0000034	-0.0000004	0.000003	0.0000033
SUMS	26.5171212	-10.830298	20.0134682	31.9193922	-40.553557	39.2706882

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1981
NEPTUNE AND PLUTO

DAYS 1 THRU 95 JD 2444605.5 TO 2444700.5 DATES JAN 1 THRU APR 5

A = 47.5 B = -1.02105263 W = 1

TERM	NEPTUNE R A H	NEPTUNE DEC DEG	NEPTUNE DISTANCE AU	PLUTO R A † H	PLUTO DEC † DEG	PLUTO DISTANCE AU
0	35.1662994	-43.989290	61.2459377	27.7513423	14.128559	59.2265328
1	0.0653475	-0.017048	-0.6767562	-0.0224263	0.514640	-0.6073853
2	-0.0187856	0.016029	-0.0680819	-0.0175434	0.049944	0.0877865
3	-0.0014080	-0.000793	0.0195655	0.0011899	-0.019706	0.0180554
4	0.0002480	-0.000150	0.0010053	0.0002988	-0.001010	-0.0013623
5	0.0000170	0.000019	-0.0001807	-0.0000093	0.000223	-0.0002023
6	-0.0000027	-0.000004	-0.0000151	-0.0000044	0.000021	0.0000128
7	0.0	0.0	-0.0000011	-0.0000001	0.0	-0.0000007
8	-0.0000018	-0.000003	-0.0000110	-0.0000017	0.000008	0.0000027
9	-0.0000027	0.000009	0.0000129	0.0000003	-0.000010	0.0000185
10	0.0000006	0.0	0.0000125	0.0000020	-0.000010	-0.0000035
11	0.0000007	0.000005	-0.0000083	-0.0000003	0.000007	-0.0000116
SUMS	35.2117124	-43.991226	60.5214796	27.7128478	14.672666	58.7234430

DAYS 91 THRU 185 JD 2444695.5 TO 2444790.5 DATES APR 1 THRU JULY 4

A = 47.5 B = -2.91578947 W = 91

TERM	NEPTUNE R A H	NEPTUNE DEC DEG	NEPTUNE DISTANCE AU	PLUTO R A † H	PLUTO DEC † DEG	PLUTO DISTANCE AU
0	35.1433968	-43.898422	59.0216279	27.5551363	15.547556	58.7576879
1	-0.0710080	0.054348	-0.3406806	-0.0607940	0.094711	0.3855722
2	-0.0101626	0.001560	0.1399657	0.0093109	-0.134610	0.1223857
3	0.0027353	-0.001703	0.0096183	0.0023101	-0.004697	-0.0123979
4	0.0001637	-0.000098	-0.0020263	-0.0001821	0.002176	-0.0015899
5	-0.0000281	-0.000002	-0.0000857	-0.0000208	-0.000011	0.0001456
6	-0.0000012	0.000004	0.0000232	0.0000030	-0.000026	0.0000161
7	0.0000002	-0.000002	-0.0000006	-0.0000002	0.000002	0.0
8	-0.0000001	0.000001	0.0000125	0.0000007	-0.000010	0.0000126
9	0.0000012	-0.000008	0.0000104	0.0000022	-0.000008	-0.0000097
10	0.0000018	-0.000004	-0.0000146	-0.0000009	0.000012	-0.0000145
11	-0.0000011	-0.000008	-0.0000064	-0.0000014	0.000005	0.0000057
SUMS	35.0650979	-43.844334	58.8284438	27.5057638	15.505100	59.2518138

†ASTROMETRIC POSITION, EQUINOX AND EQUATOR 1950.0

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1981
NEPTUNE AND PLUTO

DAYS 182 THRU 276 JD 2444786.5 TO 2444881.5 DATES JULY 1 THRU OCT 3

A = 47.5 B = -4.83157895 W = 182

TERM	NEPTUNE R A H	NEPTUNE DEC DEG	NEPTUNE DISTANCE AU	PLUTO R A † H	PLUTO DEC † DEG	PLUTO DISTANCE AU
0	34.9126813	-43.793463	59.7286867	27.5406239	14.214689	60.9074546
1	-0.0267903	-0.014674	0.6570595	0.0581518	-0.719191	0.5833071
2	0.0190458	-0.017599	0.0720551	0.0158860	-0.043440	-0.0763957
3	0.0012260	-0.000401	-0.0186898	-0.0011124	0.015883	-0.0159983
4	-0.0002841	0.000361	-0.0009440	-0.0001778	0.000354	0.0009656
5	-0.0000064	0.000017	0.0001664	0.0000108	-0.000103	0.0001084
6	0.0000026	0.000001	0.0000032	0.0000008	0.000002	-0.0000128
7	0.0000001	-0.000001	0.0000017	0.0000002	-0.000002	0.0000014
8	0.0000012	0.000004	-0.0000003	0.0000010	-0.000001	-0.0000126
9	0.0000015	-0.000001	-0.0000192	-0.0000018	0.000015	-0.0000096
10	-0.0000020	0.000004	-0.0000002	-0.0000012	0.0	0.0000144
11	0.0000009	0.000004	0.0000122	0.0000012	-0.000009	0.0000063
SUMS	34.9058766	-43.825748	60.4383313	27.6133825	13.468197	61.3994288

DAYS 274 THRU 368 JD 2444878.5 TO 2444973.5 DATES OCT 1 THRU JAN 3

A = 47.5 B = -6.76842105 W = 274

TERM	NEPTUNE R A H	NEPTUNE DEC DEG	NEPTUNE DISTANCE AU	PLUTO R A † H	PLUTO DEC † DEG	PLUTO DISTANCE AU
0	35.0860089	-44.031903	62.0011981	27.8826377	11.855296	61.3834044
1	0.1088021	-0.091469	0.3508254	0.1004113	-0.369313	-0.3791977
2	0.0096861	0.003347	-0.1365670	-0.0069948	0.120950	-0.1284110
3	-0.0024257	0.002672	-0.0102667	-0.0022839	0.008169	0.0094694
4	-0.0001235	-0.000145	0.0018638	0.0000531	-0.001424	0.0019001
5	0.0000182	-0.000044	0.0000841	0.0000176	-0.000095	-0.0000586
6	-0.0000012	-0.000001	-0.0000181	-0.0000007	0.000009	-0.0000113
7	0.0	0.0	-0.0000020	-0.0000001	0.000001	-0.0000028
8	-0.0000015	-0.000004	-0.0000114	-0.0000018	0.000009	0.0000020
9	-0.0000024	0.000008	0.0000121	0.0000001	-0.000008	0.0000188
10	0.0000005	-0.000001	0.0000129	0.0000020	-0.000010	-0.0000027
11	0.0000004	0.000005	-0.0000082	-0.0000001	0.000006	-0.0000117
SUMS	35.2019619	-44.117535	62.2071230	27.9738404	11.613590	60.8870989

†ASTROMETRIC POSITION, EQUINOX AND EQUATOR 1950.0

CHEBYSHEV APPROXIMATION OF SIDEREAL TIME FOR YEAR 1981

DAYS 1 THRU 366 JD 2444605.5 TO 2444971.5 DATES JAN 1 THRU JAN 1

A = 183.0 B = -1.00546448 W = 1

	APP S T	EQ OF EQ	NUT LON	NUT OBL
TERM	H	S	''	''
0	37.45736644	-1.7739	-29.0017	-10.0696
1	12.02486204	-0.1284	-2.0988	1.2408
2	0.00000651	0.0234	0.3830	-0.2546
3	-0.00000090	-0.0032	-0.0530	-0.0316
4	0.00000563	0.0203	0.3314	-0.3432
5	0.00001712	0.0616	1.0076	0.1965
6	-0.00000514	-0.0185	-0.3026	0.2969
7	-0.00000487	-0.0175	-0.2864	-0.0457
8	0.00000126	0.0045	0.0740	-0.0912
9	0.00000149	0.0054	0.0878	0.0179
SUMS	49.48224958	-1.8263	-29.8587	-9.0838

CHEBYSHEV APPROXIMATION OF SOLAR COORDINATES FOR YEAR 1981

DAYS 1 THRU 366 JD 2444605.5 TO 2444971.5 DATES JAN 1 THRU JAN 1

A = 183.0 B = -1.00546448 W = 1

	R A	DEC	DISTANCE	S D	EPHEM TR
TERM	H	DEG	AU	'	H
0	61.4822161	-13.448917	1.99000552	32.20494	24.0267581
1	11.8888050	-2.545772	0.00026253	-0.00426	-0.1355983
2	0.0316312	-22.455831	-0.01628221	0.26216	0.0342762
3	0.0729746	2.932212	-0.00030523	0.00488	0.0730723
4	0.0421818	6.640391	0.00501259	-0.07888	0.0436374
5	0.1036318	-0.392400	0.00004084	-0.00056	0.1027980
6	-0.0328361	-0.497517	-0.00041278	0.00538	-0.0341946
7	-0.0437276	0.067514	-0.00000159	-0.00001	-0.0434334
8	0.0076304	0.071033	0.00000700	0.00018	0.0079191
9	0.0074014	-0.040916	-0.00000212	0.00004	0.0073250
10	-0.0021233	-0.035263	0.00000037	-0.00003	-0.0021957
11	-0.0016556	0.012769	-0.00000104	0.00002	-0.0016131
12	0.0010535	0.008518	-0.00000557	0.00009	0.0010900
13	0.0006757	-0.003202	-0.00000065	0.00001	0.0006566
14	-0.0003838	-0.001691	-0.00000783	0.00013	-0.0004006
15	-0.0001940	0.001150	0.00000027	0.0	-0.0001876
16	0.0001112	0.000480	-0.00000635	0.00010	0.0001123
17	0.0000121	-0.000406	0.00000164	-0.00003	0.0000099
18	-0.0000421	-0.000067	-0.00000009	0.0	-0.0000434
19	-0.0000424	0.000135	0.00000139	-0.00002	-0.0000400
20	0.0000206	0.000090	0.00000711	-0.00012	0.0000244
21	0.0000036	-0.000043	-0.00000027	0.0	0.0000036
SUMS	73.5573441	-29.687733	1.97831353	32.39402	24.0799762

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1981
MERCURY AND VENUS

DAYS 1 THRU 366 JD 2444605.5 TO 2444971.5 DATES JAN 1 THRU JAN 1

A = 183.0 B = -1.00546448 W = 1

TERM	MERCURY R A	MERCURY DEC	MERCURY DISTANCE	VENUS R A	VENUS DEC	VENUS DISTANCE
	H	DEG	AU	H	DEG	AU
0	61.7405269	-16.052609	2.2594612	63.6023510	-20.080416	2.4013266
1	11.9814591	-2.402592	0.0608041	14.2219675	-3.064836	-0.6544405
2	0.2399187	-21.024447	0.2201918	-0.5942563	-17.983185	-0.3118483
3	-0.0880844	2.676907	-0.0431572	-0.2712537	8.903777	0.0535971
4	0.4475511	6.467888	0.0944790	-0.1929959	10.767675	0.0233602
5	0.4919525	-1.291367	-0.0910615	-0.0622092	-3.218778	-0.0006679
6	-0.0726449	-4.372148	0.0157330	-0.1567685	-1.994440	0.0001935
7	0.5088579	2.883488	-0.0992964	-0.0802449	0.251723	0.0025447
8	-0.5771584	2.275962	-0.1827225	0.0536095	0.103813	0.0009557
9	-0.5950335	0.062782	0.1563805	0.0182819	-0.130145	0.0000312
10	0.4630848	2.487212	0.1114170	-0.0158135	-0.009405	0.0000810
11	0.2364815	-2.577179	-0.0503476	-0.0031804	0.096337	0.0000857
12	-0.0365836	-2.788896	-0.0323301	0.0040701	0.003169	0.0000219
13	-0.1029603	1.257756	-0.0112569	-0.0004646	-0.037930	0.0000003
14	0.0004866	1.122391	0.0076667	-0.0020451	-0.000064	-0.0000070
15	0.0686176	0.403806	-0.0147592	0.0009924	0.009953	-0.0000006
16	-0.1695919	-0.276970	0.0012615	0.0012497	-0.001581	-0.0000095
17	-0.0163536	0.035285	0.0270573	-0.0003449	-0.002623	-0.0000010
18	0.1502036	0.031453	0.0003291	-0.0003892	0.001682	-0.0000050
19	0.0228860	-0.766205	-0.0029340	0.0001116	0.000982	-0.0000005
20	-0.0162477	-0.052529	-0.0088473	0.0000671	-0.000962	0.0000038
21	-0.0526641	0.389418	-0.0131757	-0.0001171	-0.000403	-0.0000003
22	-0.0307271	0.265352	0.0072637	-0.0000195	0.000406	0.0000089
23	0.0226548	0.230348	0.0090015	0.0000803	0.000153	0.0000004
24	0.0028767	-0.260338	0.0008752	0.0000265	-0.000139	0.0000023
25	0.0208090	-0.286807	-0.0017328	0.0000177	0.000022	0.0000007
26	0.0138514	-0.010540	-0.0017879	0.0000137	0.000023	-0.0000086
27	-0.0123424	0.056945	-0.0005548	-0.0000041	-0.000060	-0.0000006
28	-0.0092950	0.117766	-0.0023348	-0.0000175	0.000035	-0.0000042
29	-0.0151706	0.053128	0.0002076	-0.0000401	0.000016	-0.0000014
30	0.0025440	0.036598	0.0025580	-0.0000078	0.000057	0.0000096
31	0.0128989	-0.024929	0.0005612	0.0000200	0.000039	0.0000011
32	0.0028023	-0.134653	0.0006685	0.0000098	-0.000152	-0.0000001
33	0.0059168	-0.030038	-0.0006227	0.0000210	-0.000080	0.0000011
34	-0.0036078	0.045564	-0.0022565	0.0000016	0.000108	-0.0000101
35	-0.0111051	0.046228	-0.0002101	-0.0000352	0.000067	-0.0000023
36	-0.0019998	0.055695	0.0013994	-0.0000091	0.000002	0.0000122
37	0.0038978	-0.009202	0.0007109	0.0000275	-0.000026	0.0000022
38	0.0056016	-0.048674	-0.0003205	0.0000087	-0.000071	-0.0000085
39	0.0008001	-0.033683	-0.0002181	-0.0000145	0.000004	-0.0000015
40	-0.0018732	-0.002939	0.0000834	-0.0000032	0.000075	0.0000043
41	0.0001814	0.027876	-0.0003647	0.0000068	0.000008	0.0000006
42	-0.0025760	0.018248	-0.0002363	0.0000011	-0.000044	-0.0000019
43	-0.0020592	0.008799	0.0002477	-0.0000037	-0.000006	-0.0000003
44	0.0016817	-0.000233	0.0002380	-0.0000008	0.000025	0.0000005
45	0.0022311	-0.020703	0.0001936	0.0000013	-0.000002	0.0000002
46	0.0013988	-0.013985	-0.0000356	-0.0000004	-0.000013	-0.0000001
47	-0.0010056	0.000259	-0.0003345	-0.0000003	-0.000001	0.0000001
48	-0.0018494	0.009731	-0.0001426	0.0000006	-0.000001	0.0000001
49	-0.0003705	0.015638	0.0001673	0.0000007	0.000001	0.0
SUMS	74.6308686	-31.399143	2.4179169	76.5226986	-26.385211	1.5152258

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1981
MARS AND JUPITER

DAYS 1 THRU 366 JD 2444605.5 TO 2444971.5 DATES JAN 1 THRU JAN 1

A = 183.0 B = -1.00546448 W = 1

TERM	MARS R A H	MARS DEC DEG	MARS DISTANCE AU	JUPITER R A H	JUPITER DEC DEG	JUPITER DISTANCE AU
0	57.7373362	6.890649	4.1598170	25.9316476	-9.241476	11.0139071
1	8.2884354	10.881060	-0.4502900	0.8063042	-5.028796	0.7391452
2	-0.4367743	-16.964085	-0.3173807	0.6314552	-3.852734	0.0451735
3	-0.1708340	-0.606305	-0.0498500	0.0011636	0.282994	-0.5826934
4	-0.0645301	2.729453	0.0115076	-0.1558343	1.016784	0.0271483
5	0.0427893	-0.148109	0.0065896	0.0393457	-0.285047	0.0707082
6	0.0029222	-0.168204	0.0002032	0.0074093	-0.047535	-0.0200408
7	-0.0126767	0.008161	0.0000304	-0.0134567	0.081135	0.0002447
8	-0.0006886	0.025557	0.0000222	0.0039340	-0.028085	0.0039379
9	0.0017251	0.003263	-0.0000139	0.0013654	-0.006590	-0.0017067
10	0.0002232	-0.006057	-0.0000016	-0.0014785	0.009906	-0.0000971
11	-0.0003930	-0.000325	0.0000016	0.0003464	-0.002958	0.0003745
12	-0.0000877	0.001169	-0.0000054	0.0002002	-0.001126	-0.0001441
13	0.0000848	0.000168	0.0000025	-0.0001753	0.001295	-0.0000267
14	0.0000055	-0.000159	-0.0000040	0.0000248	-0.000293	0.0000414
15	-0.0000310	0.000025	0.0000050	0.0000308	-0.000201	-0.0000152
16	-0.0000055	0.000103	-0.0000003	-0.0000262	0.000202	-0.0000037
17	-0.0000057	0.000014	0.0000054	0.0000029	-0.000034	0.0000095
18	0.0000096	0.000010	0.0000045	0.0000020	-0.000019	-0.0000013
19	-0.0000027	-0.000045	0.0000014	-0.0000033	0.000034	0.0000075
20	0.0000105	-0.000030	0.0000060	0.0000016	-0.000012	0.0000003
21	0.0000097	-0.000049	-0.0000045	-0.0000001	0.000002	0.0000048
SUMS	65.3875222	2.646264	3.3606460	27.2522593	-17.102554	11.2959739

CHEBYSHEV APPROXIMATION OF PLANETARY COORDINATES FOR YEAR 1981
SATURN AND URANUS

DAYS 1 THRU 366 JD 2444605.5 TO 2444971.5 DATES JAN 1 THRU JAN 1

A = 183.0 B = -1.00546448 W = 1

TERM	SATURN R A H	SATURN DEC DEG	SATURN DISTANCE AU	URANUS R A H	URANUS DEC DEG	URANUS DISTANCE AU
0	25.4971384	-4.354863	19.2212706	31.6031690	-39.535914	38.0714827
1	0.3656300	-2.398019	0.7003175	0.0616430	-0.213710	0.4285962
2	0.3580949	-2.273456	-0.0102046	0.1350334	-0.430366	0.7214546
3	-0.0046792	0.226716	-0.6304830	0.1024152	-0.312216	-0.4423736
4	-0.0990595	0.628579	0.0247389	-0.0441820	0.151269	-0.2139398
5	0.0143811	-0.120517	0.0840546	-0.0147565	0.052903	0.0729470
6	0.0064375	-0.035956	-0.0136840	0.0062744	-0.021034	0.0174991
7	-0.0051290	0.032252	-0.0019107	0.0005456	-0.005761	-0.0066935
8	0.0009026	-0.007654	0.0028571	-0.0008313	0.002861	-0.0001114
9	0.0006796	-0.003503	-0.0008617	0.0000989	0.000557	0.0006173
10	-0.0003723	0.002665	-0.0002046	0.0001050	-0.000484	-0.0001262
11	0.0000180	-0.000356	0.0001828	-0.0000293	-0.000025	-0.0000707
12	0.0000606	-0.000375	-0.0000343	-0.0000115	0.000085	0.0000204
13	-0.0000268	0.000218	-0.0000242	0.0000064	-0.000011	0.0000023
14	-0.0000052	0.000009	0.0000139	-0.0000012	-0.000014	-0.0000084
15	0.0000063	-0.000046	-0.0000027	-0.0000002	-0.000003	-0.0000011
SUMS	26.1340770	-8.304306	19.3760256	31.8494789	-40.311863	38.6492949

NEPTUNE AND PLUTO

DAYS 1 THRU 366 JD 2444605.5 TO 2444971.5 DATES JAN 1 THRU JAN 1

A = 183.0 B = -1.00546448 W = 1

TERM	NEPTUNE R A H	NEPTUNE DEC DEG	NEPTUNE DISTANCE AU	PLUTO R A † H	PLUTO DEC † DEG	PLUTO DISTANCE AU
0	35.0997610	-43.969787	61.0936677	27.7516666	13.434885	60.2112174
1	0.0031592	-0.029723	0.1697362	0.0520727	-0.667417	0.4990437
2	0.0383795	-0.066253	0.9276180	0.1099167	-0.784107	0.2075010
3	0.0862003	-0.047564	-0.1977892	0.0260499	0.238948	-0.6167311
4	-0.0125712	0.021856	-0.2848170	-0.0339496	0.232608	-0.0563304
5	-0.0138488	0.009572	0.0323717	-0.0025879	-0.046152	0.0918694
6	0.0016794	-0.000353	0.0264799	0.0032984	-0.016697	0.0010523
7	0.0010864	-0.001598	-0.0027693	-0.0003526	0.005958	-0.0047211
8	-0.0002085	-0.000465	-0.0011306	-0.0001531	-0.000656	0.0009424
9	-0.0000738	0.000259	0.0002339	0.0001039	-0.000631	-0.0000736
10	0.0000275	0.000079	0.0000254	-0.0000039	0.000258	-0.0001431
11	0.0000089	-0.000045	-0.0000323	-0.0000114	0.000035	0.0000193
12	-0.0000035	-0.000009	0.0000002	0.0000028	-0.000035	0.0000086
13	-0.0000021	0.000011	0.0000056	0.0000006	0.000002	0.0000016
SUMS	35.2035943	-44.084020	61.7636002	27.9060531	12.396999	60.3336564

†ASTROMETRIC POSITION, EQUINOX AND EQUATOR 1950.0

Section E: STELLAR TABLES

	Nav. No.	A/C ID		Nav. No.	A/C ID
Acamar	7	18	Gacrux	31	88
Achernar	5	11	Gienah	29	85
Acrux	30	86	Hadar	35	104
Adhara	19	50	Hamal	6	15
Aldebaran	10	26	Kaus Australis	48	150
Alioth	32	94	Kochab	40	114
Alkaid	34	101	Markab	57	175
Al Na'ir	55	170	Menkar	8	19
Alnilam	15	37	Menkent	36	105
Alphard	25	71	Miaplacidus	24	68
Alphecca	41	120	Mirfak	9	21
Alpheratz	1	1	Nunki	50	153
Altair	51	160	Peacock	52	162
Ankaa	2	5	Pollux	21	60
Antares	42	128	Procyon	20	59
Arcturus	37	106	Rasalhague	46	143
Atria	43	133	Regulus	26	74
Avior	22	64	Rigel	11	29
Bellatrix	13	31	Rigil Kentaurus	38	109
Betelgeuse	16	42	Sabik	44	136
Canopus	17	46	Schedar	3	6
Capella	12	30	Shaula	45	142
Deneb	53	164	Sirius	18	48
Denebola	28	82	Spica	33	99
Diphda	4	7	Suhail	23	67
Dubhe	27	79	Vega	49	152
Elnath	14	32	Zubenelgenubi	39	113
Eltanin	47	147			
Enif	54	168	Polaris		17
Fomalhaut	56	173			

DAYS 1 THRU 365 JD 2444605.5 TO 2444970.5 DATES JAN 1 THRU DEC 31

A = 365.0 B = -0.00273973 W = 1

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
1	1	ALPHA AND	2.1	SHA	358.1496	0.0023	-0.0115	0.0059	0.0009	358.1452
		ALPHERATZ	A0	DEC	28.9856	-0.0015	0.0051	-0.0024	0.0024	28.9843
2		BETA CAS	2.4	SHA	357.9613	0.0004	-0.0110	0.0100	0.0015	357.9547
		CAPH	F5	DEC	59.0450	-0.0015	0.0052	-0.0019	0.0046	59.0415
3		GAMMA PEG	2.9	SHA	356.9363	0.0028	-0.0117	0.0054	0.0007	356.9325
		ALGENIB	B2	DEC	15.0781	-0.0015	0.0052	-0.0023	0.0011	15.0781
4		BETA HYI	2.9	SHA	353.8075	0.0102	-0.0122	0.0238	0.0016	353.8101
			G0	DEC	-77.3614	-0.0016	0.0052	-0.0000	-0.0056	-77.3548
5	2	ALPHA PHE	2.4	SHA	353.6633	0.0047	-0.0119	0.0071	0.0005	353.6616
		ANKAA	K0	DEC	-42.4092	-0.0016	0.0052	-0.0013	-0.0041	-42.4040
6	3	ALPHA CAS	2.3	SHA	350.1450	0.0010	-0.0122	0.0095	-0.0000	350.1400
		SCHEDAR	K0	DEC	56.4333	-0.0017	0.0052	-0.0014	0.0045	56.4297
7	4	BETA CET	2.2	SHA	349.3413	0.0037	-0.0117	0.0055	-0.0001	349.3392
		DIPHDA	K0	DEC	-18.0906	-0.0017	0.0052	-0.0021	-0.0022	-18.0875
8		GAMMA CAS	2-3	SHA	346.1125	0.0009	-0.0129	0.0107	-0.0008	346.1078
			B0	DEC	60.6142	-0.0018	0.0051	-0.0009	0.0047	60.6102
9		BETA AND	2.4	SHA	342.8342	0.0024	-0.0125	0.0064	-0.0009	342.8312
		MIRACH	M0	DEC	35.5200	-0.0019	0.0051	-0.0015	0.0029	35.5178
10		DELTA CAS	2.8	SHA	338.8600	0.0013	-0.0140	0.0104	-0.0023	338.8566
		RUCHBAH	A5	DEC	60.1369	-0.0019	0.0050	-0.0003	0.0046	60.1329
11	5	ALPHA ERI	0.6	SHA	335.7483	0.0048	-0.0094	0.0095	-0.0026	335.7511
		ACHERNAR	B5	DEC	-57.3331	-0.0020	0.0049	-0.0022	-0.0049	-57.3277
12		BETA ARI	2.7	SHA	331.6033	0.0029	-0.0125	0.0054	-0.0019	331.6019
		SHERATAN	A5	DEC	20.7156	-0.0021	0.0048	-0.0015	0.0015	20.7144
13		ALPHA HYI	3.0	SHA	330.4575	0.0047	-0.0081	0.0105	-0.0041	330.4622
			F0	DEC	-61.6619	-0.0021	0.0048	-0.0025	-0.0049	-61.6567
14		GAMMA-1 AND	2.3	SHA	329.3183	0.0025	-0.0137	0.0067	-0.0027	329.3168
		ALMAK	K0	DEC	42.2392	-0.0021	0.0047	-0.0005	0.0033	42.2362
15	6	ALPHA ARI	2.2	SHA	328.4754	0.0029	-0.0127	0.0054	-0.0023	328.4743
		HAMAL	K2	DEC	23.3731	-0.0021	0.0047	-0.0013	0.0017	23.3716
16		BETA TRI	3.1	SHA	327.8979	0.0027	-0.0133	0.0060	-0.0026	327.8966
			A5	DEC	34.8981	-0.0021	0.0047	-0.0008	0.0027	34.8956
17		ALPHA UMI	2.1	SHA	326.8271	-0.0441	-0.1704	0.3394	-0.1576	326.8554
		POLARIS	F8	DEC	89.1781	-0.0021	0.0046	0.0019	0.0052	89.1731
18	7	THETA ERI	3.4	SHA	315.6150	0.0035	-0.0091	0.0058	-0.0042	315.6181
		ACAMAR	A2	DEC	-40.3803	-0.0022	0.0041	-0.0035	-0.0033	-40.3771
19	8	ALPHA CET	2.8	SHA	314.6792	0.0032	-0.0120	0.0044	-0.0033	314.6797
		MENKAR	M0	DEC	4.0158	-0.0022	0.0041	-0.0020	-0.0001	4.0157
20		BETA PER	2-3	SHA	313.2683	0.0031	-0.0147	0.0057	-0.0045	313.2686
		ALGOL	B8	DEC	40.8833	-0.0022	0.0040	0.0003	0.0027	40.8804

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
21	9	ALPHA PER	1.9	SHA	309.2604	0.0032	-0.0160	0.0063	-0.0058	309.2614
		MIRFAK	F5	DEC	49.7947	-0.0022	0.0037	0.0011	0.0030	49.7914
22		ETA TAU	3.0	SHA	303.4121	0.0033	-0.0136	0.0041	-0.0045	303.4132
		ALCYONE	B5	DEC	24.0472	-0.0022	0.0034	-0.0005	0.0012	24.0455
23		ZETA PER	2.9	SHA	301.7663	0.0034	-0.0143	0.0042	-0.0050	301.7675
			B1	DEC	31.8281	-0.0022	0.0032	0.0001	0.0016	31.8258
24		EPSILON PER	3.0	SHA	300.8563	0.0035	-0.0152	0.0046	-0.0056	300.8578
			B1	DEC	39.9564	-0.0022	0.0032	0.0008	0.0021	39.9537
25		GAMMA ERI	3.2	SHA	300.7146	0.0032	-0.0108	0.0036	-0.0044	300.7168
			K5	DEC	-13.5619	-0.0022	0.0032	-0.0031	-0.0013	-13.5613
26	10	ALPHA TAU	1.1	SHA	291.2929	0.0034	-0.0132	0.0030	-0.0051	291.2949
		ALDEBARAN	K5	DEC	16.4719	-0.0021	0.0025	-0.0009	0.0004	16.4706
27		IOTA AUR	2.9	SHA	286.0617	0.0038	-0.0149	0.0029	-0.0061	286.0641
			K2	DEC	33.1372	-0.0021	0.0020	0.0007	0.0010	33.1352
28		BETA ERI	2.9	SHA	283.2713	0.0032	-0.0114	0.0022	-0.0052	283.2740
			A3	DEC	-5.1100	-0.0020	0.0018	-0.0026	-0.0006	-5.1105
29	11	BETA ORI	0.3	SHA	281.5942	0.0031	-0.0111	0.0021	-0.0053	281.5971
		RIGEL	B8	DEC	-8.2228	-0.0020	0.0017	-0.0029	-0.0007	-8.2232
30	12	ALPHA AUR	0.2	SHA	281.1792	0.0043	-0.0169	0.0029	-0.0076	281.1827
		CAPELLA	G0	DEC	45.9800	-0.0020	0.0016	0.0019	0.0012	45.9777
31	13	GAMMA ORI	1.7	SHA	278.9721	0.0034	-0.0124	0.0018	-0.0054	278.9747
		BELLATRIX	B2	DEC	6.3333	-0.0019	0.0014	-0.0017	-0.0002	6.3323
32	14	BETA TAU	1.8	SHA	278.7275	0.0039	-0.0145	0.0021	-0.0061	278.7302
		ELNATH	B8	DEC	28.5925	-0.0019	0.0014	0.0004	0.0005	28.5908
33		BETA LEP	3.0	SHA	278.1421	0.0028	-0.0099	0.0019	-0.0058	278.1457
			G0	DEC	-20.7739	-0.0019	0.0014	-0.0038	-0.0010	-20.7741
34		DELTA ORI	2.5	SHA	277.2413	0.0032	-0.0118	0.0017	-0.0054	277.2440
			B0	DEC	-0.3122	-0.0019	0.0013	-0.0023	-0.0004	-0.3131
35		ALPHA LEP	2.7	SHA	277.0271	0.0029	-0.0102	0.0017	-0.0057	277.0306
			F0	DEC	-17.8350	-0.0019	0.0013	-0.0036	-0.0009	-17.8354
36		IOTA ORI	2.9	SHA	276.3742	0.0031	-0.0113	0.0016	-0.0055	276.3771
			O5	DEC	-5.9214	-0.0019	0.0012	-0.0027	-0.0006	-5.9221
37	15	EPSILON ORI	1.7	SHA	276.1879	0.0032	-0.0117	0.0016	-0.0055	276.1907
		ALNILAM	B0	DEC	-1.2131	-0.0019	0.0012	-0.0023	-0.0004	-1.2139
38		ZETA TAU	3.0	SHA	275.8729	0.0037	-0.0138	0.0017	-0.0059	275.8756
			B3	DEC	21.1319	-0.0019	0.0012	-0.0003	0.0002	21.1305
39		ALPHA COL	2.7	SHA	275.2600	0.0024	-0.0084	0.0018	-0.0066	275.2648
		PHACT	B5	DEC	-34.0836	-0.0019	0.0011	-0.0047	-0.0012	-34.0837
40		ZETA ORI	2.0	SHA	275.0500	0.0032	-0.0116	0.0015	-0.0055	275.0529
		ALNITAK	B0	DEC	-1.9517	-0.0018	0.0011	-0.0024	-0.0005	-1.9525
41		KAPPA ORI	2.2	SHA	273.2863	0.0030	-0.0109	0.0014	-0.0056	273.2894
			B0	DEC	-9.6756	-0.0018	0.0009	-0.0030	-0.0006	-9.6763
42	16	ALPHA ORI	0-1	SHA	271.4642	0.0034	-0.0125	0.0012	-0.0056	271.4670
		BETELGEUSE	M0	DEC	7.4044	-0.0018	0.0008	-0.0015	-0.0003	7.4033
43		BETA AUR	2.1	SHA	270.4663	0.0046	-0.0169	0.0015	-0.0079	270.4703
		MENKALINAN	A0	DEC	44.9469	-0.0017	0.0007	0.0020	0.0004	44.9451

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
44		THETA AUR	2.7	SHA	270.3938	0.0043	-0.0157	0.0014	-0.0070	270.3972
			A0	DEC	37.2125	-0.0017	0.0007	0.0013	0.0003	37.2108
45		BETA CMA	2.0	SHA	264.5346	0.0027	-0.0101	0.0006	-0.0060	264.5382
		MIRZAM	B1	DEC	-17.9458	-0.0016	0.0001	-0.0037	-0.0005	-17.9468
46	17	ALPHA CAR	-0.9	SHA	264.1175	0.0012	-0.0050	0.0008	-0.0093	264.1255
		CANOPUS	F0	DEC	-52.6850	-0.0016	0.0001	-0.0055	-0.0006	-52.6860
47		GAMMA GEM	1.9	SHA	260.8463	0.0037	-0.0133	0.0002	-0.0059	260.8492
		ALHENA	A0	DEC	16.4164	-0.0015	-0.0002	-0.0007	-0.0004	16.4152
48	18	ALPHA CMA A	-1.6	SHA	258.9229	0.0027	-0.0103	0.0000	-0.0059	258.9264
		SIRIUS	A0	DEC	-16.6897	-0.0014	-0.0004	-0.0036	-0.0004	-16.6910
49		TAU PUP	2.8	SHA	257.6342	0.0011	-0.0055	-0.0001	-0.0089	257.6415
			K0	DEC	-50.5917	-0.0014	-0.0005	-0.0055	-0.0001	-50.5932
50	19	EPSILON CMA	1.6	SHA	255.5304	0.0022	-0.0090	-0.0003	-0.0065	255.5346
		ADHARA	B1	DEC	-28.9456	-0.0013	-0.0007	-0.0045	-0.0001	-28.9471
51		OMICRON-2 CMA	3.1	SHA	254.4421	0.0024	-0.0095	-0.0004	-0.0062	254.4459
			B5	DEC	-23.8047	-0.0013	-0.0008	-0.0041	-0.0001	-23.8062
52		DELTA CMA	2.0	SHA	253.0954	0.0023	-0.0093	-0.0006	-0.0063	253.0994
		WEZEN	F8	DEC	-26.3622	-0.0012	-0.0009	-0.0043	-0.0001	-26.3639
53		PI PUP	2.7	SHA	250.8821	0.0018	-0.0080	-0.0009	-0.0070	250.8869
			K5	DEC	-37.0628	-0.0012	-0.0011	-0.0049	0.0002	-37.0647
54		ETA CMA	2.4	SHA	249.1642	0.0022	-0.0090	-0.0010	-0.0064	249.1682
			B5	DEC	-29.2653	-0.0011	-0.0012	-0.0045	0.0002	-29.2672
55		BETA CMI	3.1	SHA	248.4700	0.0035	-0.0125	-0.0009	-0.0056	248.4729
			B8	DEC	8.3286	-0.0011	-0.0013	-0.0015	-0.0006	8.3275
56		SIGMA PUP	3.3	SHA	247.8433	0.0014	-0.0071	-0.0013	-0.0076	247.8488
			K5	DEC	-43.2625	-0.0011	-0.0013	-0.0052	0.0005	-43.2648
57		ALPHA GEM A	2.0	SHA	246.6533	0.0045	-0.0149	-0.0013	-0.0065	246.6569
		CASTOR	A0	DEC	31.9311	-0.0010	-0.0014	0.0008	-0.0011	31.9304
58		ALPHA GEM B	2.8	SHA	246.6525	0.0045	-0.0149	-0.0013	-0.0065	246.6560
			A0	DEC	31.9311	-0.0010	-0.0014	0.0008	-0.0011	31.9304
59	20	ALPHA CMI A	0.5	SHA	245.4229	0.0034	-0.0123	-0.0012	-0.0055	245.4257
		PROCYON	F5	DEC	5.2742	-0.0010	-0.0016	-0.0017	-0.0005	5.2729
60	21	BETA GEM	1.2	SHA	243.9613	0.0043	-0.0144	-0.0015	-0.0062	243.9645
		POLLUX	K0	DEC	28.0731	-0.0009	-0.0017	0.0004	-0.0011	28.0724
61		ZETA PUP	2.3	SHA	239.2708	0.0015	-0.0078	-0.0023	-0.0069	239.2753
			O	DEC	-39.9492	-0.0008	-0.0021	-0.0049	0.0010	-39.9520
62		RHO PUP	2.9	SHA	238.3163	0.0023	-0.0097	-0.0020	-0.0058	238.3195
			F5	DEC	-24.2489	-0.0007	-0.0022	-0.0040	0.0005	-24.2512
63		GAMMA-2 VEL	1.9	SHA	237.7633	0.0010	-0.0067	-0.0027	-0.0077	237.7687
			O	DEC	-47.2803	-0.0007	-0.0022	-0.0051	0.0013	-47.2834
64	22	EPSILON CAR	1.7	SHA	234.4688	-0.0004	-0.0041	-0.0042	-0.0101	234.4764
		AVIOR	*	DEC	-59.4481	-0.0006	-0.0025	-0.0053	0.0019	-59.4518
65		DELTA VEL	2.0	SHA	228.9554	0.0001	-0.0058	-0.0045	-0.0084	228.9611
			A0	DEC	-54.6383	-0.0004	-0.0029	-0.0050	0.0022	-54.6423
66		IOTA UMA	3.1	SHA	225.5221	0.0057	-0.0164	-0.0043	-0.0070	225.5266
			A5	DEC	48.1169	-0.0002	-0.0031	0.0018	-0.0027	48.1178

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
67	23	LAMBDA VEL	2.2	SHA	223.1758	0.0011	-0.0081	-0.0042	-0.0062	223.1792
		SUHAIL	K5	DEC	-43.3556	-0.0002	-0.0033	-0.0046	0.0021	-43.3594
68	24	BETA CAR	1.8	SHA	221.7504	-0.0028	-0.0013	-0.0090	-0.0128	221.7598
		MIAPLACIDUS	A0	DEC	-69.6389	-0.0001	-0.0034	-0.0047	0.0032	-69.6439
69		IOTA CAR	2.2	SHA	220.8546	-0.0005	-0.0054	-0.0063	-0.0086	220.8600
			F0	DEC	-59.1953	-0.0001	-0.0035	-0.0047	0.0029	-59.2000
70		KAPPA VEL	2.6	SHA	219.6188	0.0001	-0.0064	-0.0057	-0.0075	219.6231
			B3	DEC	-54.9292	-0.0000	-0.0035	-0.0046	0.0028	-54.9338
71	25	ALPHA HYA	2.2	SHA	218.3367	0.0029	-0.0112	-0.0034	-0.0043	218.3382
		ALPHARD	K2	DEC	-8.5758	0.0000	-0.0036	-0.0028	0.0002	-8.5778
72		N VEL	3.0	SHA	217.3392	-0.0002	-0.0062	-0.0063	-0.0076	217.3435
			K5	DEC	-56.9503	0.0001	-0.0037	-0.0045	0.0030	-56.9551
73		EPSILON LEO	3.1	SHA	213.8063	0.0042	-0.0133	-0.0040	-0.0043	213.8081
			G0	DEC	23.8622	0.0002	-0.0039	-0.0005	-0.0020	23.8625
74	26	ALPHA LEO	1.3	SHA	208.1596	0.0037	-0.0124	-0.0041	-0.0036	208.1606
		REGULUS	B8	DEC	12.0606	0.0004	-0.0042	-0.0015	-0.0013	12.0602
75		GAMMA-1 LEO	2.6	SHA	205.2683	0.0040	-0.0128	-0.0045	-0.0035	205.2694
		ALGEIBA	K0	DEC	19.9381	0.0005	-0.0044	-0.0010	-0.0020	19.9384
76		THETA CAR	3.0	SHA	199.4308	-0.0011	-0.0070	-0.0104	-0.0064	199.4326
			B0	DEC	-64.2947	0.0007	-0.0046	-0.0034	0.0043	-64.3006
77		MU VEL	2.8	SHA	198.5129	0.0008	-0.0092	-0.0070	-0.0041	198.5132
			G5	DEC	-49.3194	0.0008	-0.0047	-0.0034	0.0035	-49.3245
78		BETA UMA	2.4	SHA	194.8242	0.0063	-0.0147	-0.0085	-0.0043	194.8274
		MERAK	A0	DEC	56.4844	0.0009	-0.0048	0.0007	-0.0045	56.4875
79	27	ALPHA UMA	1.9	SHA	194.3588	0.0070	-0.0153	-0.0100	-0.0049	194.3630
		DUBHE	K0	DEC	61.8536	0.0009	-0.0048	0.0010	-0.0048	61.8569
80		PSI UMA	3.1	SHA	192.8500	0.0052	-0.0135	-0.0067	-0.0031	192.8515
			K0	DEC	44.6017	0.0010	-0.0049	-0.0001	-0.0040	44.6042
81		DELTA LEO	2.6	SHA	191.7250	0.0040	-0.0124	-0.0051	-0.0022	191.7250
			A3	DEC	20.6278	0.0010	-0.0049	-0.0014	-0.0023	20.6286
82	28	BETA LEO	2.2	SHA	182.9771	0.0037	-0.0120	-0.0052	-0.0013	182.9761
		DENEBOLA	A2	DEC	14.6781	0.0013	-0.0051	-0.0018	-0.0018	14.6786
83		GAMMA UMA	2.5	SHA	181.7908	0.0057	-0.0129	-0.0086	-0.0019	181.7920
		PHECDA	A0	DEC	53.8003	0.0014	-0.0051	-0.0003	-0.0047	53.8038
84		DELTA CEN	2.9	SHA	178.1583	0.0012	-0.0112	-0.0081	-0.0012	178.1551
			B3	DEC	-50.6167	0.0015	-0.0051	-0.0021	0.0041	-50.6219
85	29	GAMMA CRV	2.8	SHA	176.2933	0.0027	-0.0117	-0.0054	-0.0006	176.2908
		GIENAH	B8	DEC	-17.4367	0.0015	-0.0052	-0.0023	0.0013	-17.4390
86	30	ALPHA CRU A	1.6	SHA	173.6171	0.0002	-0.0117	-0.0115	-0.0007	173.6121
		ACRUX	B1	DEC	-62.9939	0.0016	-0.0052	-0.0014	0.0049	-62.9997
87		ALPHA CRU B	2.1	SHA	173.6146	0.0002	-0.0117	-0.0115	-0.0007	173.6096
			B3	DEC	-62.9942	0.0016	-0.0052	-0.0014	0.0049	-63.0000
88	31	GAMMA CRU	1.6	SHA	172.4742	0.0009	-0.0119	-0.0096	-0.0004	172.4695
		GACRUX	M3	DEC	-57.0069	0.0016	-0.0052	-0.0015	0.0045	-57.0124
89		BETA CRV	2.8	SHA	171.6533	0.0026	-0.0119	-0.0057	-0.0001	171.6501
			G5	DEC	-23.2919	0.0016	-0.0052	-0.0022	0.0019	-23.2948

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
90		ALPHA MUS	2.9	SHA	170.9904	-0.0006	-0.0123	-0.0146	-0.0002	170.9838
			B3	DEC	-69.0311	0.0017	-0.0052	-0.0010	0.0052	-69.0372
91		GAMMA CEN	2.4	SHA	169.8846	0.0016	-0.0121	-0.0080	0.0001	169.8800
		MUHLIFAIN	A0	DEC	-48.8556	0.0017	-0.0052	-0.0016	0.0040	-48.8605
92		GAMMA VIR	2.9	SHA	169.8263	0.0032	-0.0118	-0.0052	0.0000	169.8235
			F0	DEC	-1.3456	0.0017	-0.0052	-0.0022	-0.0003	-1.3462
93		BETA CRU	1.5	SHA	168.3496	0.0008	-0.0125	-0.0104	0.0004	168.3438
		MIMOSA	B1	DEC	-59.5853	0.0017	-0.0052	-0.0011	0.0047	-59.5908
94	32	EPSILON UMA	1.7	SHA	166.7008	0.0053	-0.0110	-0.0094	0.0006	166.7000
		ALIOTH	A0	DEC	56.0628	0.0018	-0.0051	-0.0014	-0.0049	56.0669
95		ALPHA-2 CVN	2.9	SHA	166.2150	0.0043	-0.0113	-0.0067	0.0005	166.2131
		COR CAROLI	A0	DEC	38.4206	0.0018	-0.0051	-0.0019	-0.0038	38.4236
96		EPSILON VIR	2.9	SHA	164.6925	0.0035	-0.0117	-0.0053	0.0006	164.6896
			K0	DEC	11.0608	0.0018	-0.0051	-0.0023	-0.0015	11.0616
97		IOTA CEN	2.9	SHA	160.1192	0.0024	-0.0127	-0.0065	0.0012	160.1140
			A2	DEC	-36.6125	0.0019	-0.0050	-0.0013	0.0030	-36.6161
98		ZETA UMA	2.4	SHA	159.2092	0.0048	-0.0101	-0.0090	0.0019	159.2071
		MIZAR	A2	DEC	55.0242	0.0019	-0.0050	-0.0020	-0.0048	55.0284
99	33	ALPHA VIR	1.2	SHA	158.9525	0.0030	-0.0120	-0.0053	0.0011	158.9484
		SPICA	B2	DEC	-11.0625	0.0019	-0.0050	-0.0020	0.0007	-11.0637
100		EPSILON CEN	2.6	SHA	155.3313	0.0019	-0.0139	-0.0086	0.0025	155.3238
			B1	DEC	-53.3703	0.0020	-0.0049	-0.0004	0.0042	-53.3749
101	34	ETA UMA	1.9	SHA	153.3017	0.0043	-0.0098	-0.0078	0.0025	153.2985
		ALKAID	B3	DEC	49.4078	0.0020	-0.0049	-0.0025	-0.0044	49.4118
102		ETA BOO	2.8	SHA	151.5554	0.0035	-0.0112	-0.0053	0.0019	151.5514
			G0	DEC	18.4925	0.0021	-0.0048	-0.0026	-0.0021	18.4943
103		ZETA CEN	3.1	SHA	151.4133	0.0023	-0.0139	-0.0074	0.0027	151.4060
			B2	DEC	-47.1953	0.0021	-0.0048	-0.0004	0.0037	-47.1993
104	35	BETA CEN	0.9	SHA	149.3821	0.0019	-0.0154	-0.0100	0.0041	149.3722
		HADAR	B1	DEC	-60.2819	0.0021	-0.0047	0.0004	0.0044	-60.2866
105	36	THETA CEN	2.3	SHA	148.6104	0.0027	-0.0134	-0.0061	0.0026	148.6038
		MENKENT	K0	DEC	-36.2769	0.0021	-0.0047	-0.0007	0.0028	-36.2800
106	37	ALPHA BOO	0.2	SHA	146.3017	0.0035	-0.0110	-0.0051	0.0024	146.2972
		ARCTURUS	K0	DEC	19.2808	0.0021	-0.0046	-0.0028	-0.0021	19.2828
107		GAMMA BOO	3.0	SHA	142.1721	0.0036	-0.0097	-0.0060	0.0034	142.1675
			F0	DEC	38.3908	0.0022	-0.0044	-0.0032	-0.0034	38.3942
108		ETA CEN	2.6	SHA	141.4267	0.0028	-0.0142	-0.0063	0.0037	141.4187
			*	DEC	-42.0750	0.0022	-0.0044	-0.0001	0.0030	-42.0781
109	38	ALPHA CEN A	0.3	SHA	140.4221	0.0025	-0.0168	-0.0095	0.0058	140.4104
		RIGIL KENT.	G0	DEC	-60.7553	0.0022	-0.0044	0.0011	0.0041	-60.7594
110		ALPHA CEN B	1.7	SHA	140.4283	0.0025	-0.0168	-0.0095	0.0058	140.4166
			K5	DEC	-60.7606	0.0022	-0.0044	0.0011	0.0041	-60.7646
111		ALPHA LUP	2.9	SHA	139.8354	0.0028	-0.0149	-0.0068	0.0042	139.8265
			B2	DEC	-47.3075	0.0022	-0.0043	0.0003	0.0033	-47.3108
112		EPSILON BOO	2.7	SHA	138.9608	0.0034	-0.0103	-0.0051	0.0033	138.9558
			K0	DEC	27.1536	0.0022	-0.0043	-0.0032	-0.0026	27.1562

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
113	39	ALPHA-2 LIB	2.9	SHA	137.5442	0.0031	-0.0127	-0.0047	0.0032	137.5378
		ZUBENELGENUBI	A3	DEC	-15.9636	0.0022	-0.0042	-0.0014	0.0009	-15.9644
114	40	BETA UMI	2.2	SHA	137.3129	0.0044	-0.0011	-0.0165	0.0114	137.3053
		KOCHAB	K5	DEC	74.2331	0.0022	-0.0042	-0.0032	-0.0047	74.2379
115		BETA LUP	2.8	SHA	135.6800	0.0030	-0.0147	-0.0060	0.0044	135.6712
			B2	DEC	-43.0583	0.0022	-0.0041	0.0003	0.0029	-43.0611
116		BETA LIB	2.7	SHA	131.0046	0.0032	-0.0124	-0.0042	0.0036	130.9980
			B8	DEC	-9.3136	0.0022	-0.0038	-0.0017	0.0003	-9.3136
117		GAMMA TRA	3.1	SHA	130.7208	0.0031	-0.0207	-0.0114	0.0099	130.7037
			A0	DEC	-68.6106	0.0022	-0.0038	0.0022	0.0039	-68.6142
118		GAMMA UMI	3.1	SHA	129.8129	0.0033	-0.0010	-0.0132	0.0119	129.8039
			A2	DEC	71.9017	0.0022	-0.0038	-0.0038	-0.0042	71.9062
119		GAMMA LUP	2.9	SHA	126.5329	0.0033	-0.0151	-0.0052	0.0052	126.5235
			B3	DEC	-41.1039	0.0022	-0.0036	0.0006	0.0024	-41.1058
120	41	ALPHA CRB	2.3	SHA	126.5296	0.0032	-0.0099	-0.0044	0.0044	126.5234
		ALPHECCA	A0	DEC	26.7778	0.0022	-0.0036	-0.0036	-0.0022	26.7804
121		ALPHA SER	2.7	SHA	124.1675	0.0032	-0.0114	-0.0038	0.0041	124.1609
			K0	DEC	6.4844	0.0022	-0.0034	-0.0026	-0.0009	6.4858
122		BETA TRA	3.0	SHA	121.6363	0.0038	-0.0199	-0.0080	0.0095	121.6206
			F0	DEC	-63.3733	0.0022	-0.0032	0.0024	0.0032	-63.3759
123		PI SCO	3.0	SHA	120.5754	0.0034	-0.0138	-0.0039	0.0048	120.5671
			B2	DEC	-26.0606	0.0022	-0.0032	-0.0003	0.0012	-26.0612
124		DELTA SCO	2.5	SHA	120.1983	0.0034	-0.0135	-0.0038	0.0047	120.1902
		DSCHUBBA	B0	DEC	-22.5686	0.0022	-0.0031	-0.0006	0.0010	-22.5690
125		BETA-1 SCO	2.9	SHA	118.9179	0.0034	-0.0133	-0.0036	0.0047	118.9099
			B1	DEC	-19.7544	0.0022	-0.0030	-0.0007	0.0008	-19.7546
126		DELTA OPH	3.0	SHA	116.6629	0.0033	-0.0121	-0.0032	0.0046	116.6556
			M0	DEC	-3.6464	0.0022	-0.0029	-0.0020	-0.0002	-3.6454
127		ETA DRA	2.9	SHA	114.0675	0.0022	-0.0036	-0.0064	0.0099	114.0579
			G5	DEC	61.5569	0.0022	-0.0027	-0.0048	-0.0030	61.5607
128	42	ALPHA SCO A	1.2	SHA	112.9400	0.0035	-0.0140	-0.0033	0.0053	112.9312
		ANTARES	M0	DEC	-26.3908	0.0021	-0.0026	-0.0001	0.0010	-26.3910
129		BETA HER	2.8	SHA	112.6496	0.0030	-0.0100	-0.0032	0.0052	112.6424
			.K0	DEC	21.5300	0.0021	-0.0026	-0.0037	-0.0015	21.5324
130		TAU SCO	2.9	SHA	111.3258	0.0036	-0.0142	-0.0032	0.0055	111.3168
			B0	DEC	-28.1778	0.0021	-0.0025	0.0001	0.0010	-28.1779
131		ZETA OPH	2.7	SHA	110.9725	0.0034	-0.0127	-0.0029	0.0050	110.9646
			B0	DEC	-10.5297	0.0021	-0.0024	-0.0014	0.0001	-10.5289
132		ZETA HER	3.0	SHA	109.8579	0.0028	-0.0090	-0.0032	0.0058	109.8504
			G0	DEC	31.6364	0.0021	-0.0023	-0.0042	-0.0018	31.6391
133	43	ALPHA TRA	1.9	SHA	108.3396	0.0053	-0.0240	-0.0073	0.0140	108.3189
		ATRIA	K2	DEC	-68.9947	0.0021	-0.0022	0.0034	0.0023	-68.9961
134		EPSILON SCO	2.4	SHA	107.7675	0.0038	-0.0150	-0.0031	0.0061	107.7577
			K0	DEC	-34.2600	0.0021	-0.0022	0.0007	0.0011	-34.2601
135		ZETA ARA	3.1	SHA	105.7396	0.0045	-0.0189	-0.0043	0.0092	105.7255
			K5	DEC	-55.9617	0.0020	-0.0020	0.0026	0.0018	-55.9624

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
136	44	ETA OPH	2.6	SHA	102.6783	0.0035	-0.0132	-0.0022	0.0055	102.6698
		SABIK	A2	DEC	-15.7025	0.0020	-0.0017	-0.0008	0.0002	-15.7016
137		ALPHA HER	3-4	SHA	101.5550	0.0030	-0.0105	-0.0021	0.0055	101.5472
			M3	DEC	14.4111	0.0020	-0.0017	-0.0034	-0.0009	14.4132
138		BETA ARA	2.8	SHA	99.0713	0.0049	-0.0190	-0.0033	0.0095	99.0571
			K2	DEC	-55.5136	0.0019	-0.0014	0.0028	0.0013	-55.5137
139		UPSILON SCO	2.8	SHA	97.6325	0.0041	-0.0156	-0.0022	0.0068	97.6220
			B3	DEC	-37.2822	0.0019	-0.0013	0.0012	0.0007	-37.2817
140		BETA DRA	3.0	SHA	97.4996	0.0017	-0.0053	-0.0028	0.0089	97.4898
			G0	DEC	52.3147	0.0019	-0.0013	-0.0053	-0.0016	52.3176
141		ALPHA ARA	3.0	SHA	97.4075	0.0046	-0.0177	-0.0026	0.0084	97.3948
			B3	DEC	-49.8628	0.0019	-0.0013	0.0024	0.0010	-49.8625
142	45	LAMBDA SCO	1.7	SHA	96.9208	0.0041	-0.0156	-0.0021	0.0068	96.9104
		SHAULA	B2	DEC	-37.0911	0.0019	-0.0013	0.0012	0.0006	-37.0905
143	46	ALPHA OPH	2.1	SHA	96.4871	0.0030	-0.0107	-0.0017	0.0056	96.4791
		RASALHAGUE	A5	DEC	12.5728	0.0019	-0.0012	-0.0033	-0.0008	12.5748
144		THETA SCO	2.0	SHA	96.0125	0.0044	-0.0165	-0.0022	0.0075	96.0012
			F0	DEC	-42.9872	0.0019	-0.0012	0.0018	0.0007	-42.9867
145		KAPPA SCO	2.5	SHA	94.7075	0.0043	-0.0159	-0.0019	0.0071	94.6967
			B2	DEC	-39.0217	0.0018	-0.0011	0.0014	0.0006	-39.0209
146		BETA OPH	2.9	SHA	94.3671	0.0031	-0.0114	-0.0014	0.0055	94.3590
			K0	DEC	4.5742	0.0018	-0.0010	-0.0026	-0.0005	4.5760
147	47	GAMMA DRA	2.4	SHA	90.9592	0.0015	-0.0054	-0.0018	0.0090	90.9490
		ELTANIN	K5	DEC	51.4906	0.0018	-0.0007	-0.0054	-0.0011	51.4930
148		GAMMA SGR	3.1	SHA	88.8533	0.0041	-0.0148	-0.0011	0.0065	88.8435
			K0	DEC	-30.4258	0.0017	-0.0005	0.0007	0.0001	-30.4245
149		DELTA SGR	2.8	SHA	85.0558	0.0041	-0.0148	-0.0007	0.0065	85.0461
			K0	DEC	-29.8375	0.0016	-0.0002	0.0007	-0.0001	-29.8359
150	48	EPSILON SGR	1.9	SHA	84.2725	0.0043	-0.0153	-0.0006	0.0069	84.2623
		KAUS AUST.	A0	DEC	-34.3950	0.0016	-0.0001	0.0011	-0.0001	-34.3934
151		LAMBDA SGR	2.9	SHA	83.3008	0.0040	-0.0143	-0.0005	0.0063	83.2914
			K0	DEC	-25.4333	0.0016	-0.0000	0.0002	-0.0002	-25.4315
152	49	ALPHA LYR	0.1	SHA	80.9267	0.0019	-0.0077	-0.0003	0.0073	80.9175
		VEGA	A0	DEC	38.7653	0.0015	0.0002	-0.0050	-0.0004	38.7672
153	50	SIGMA SGR	2.1	SHA	76.4783	0.0041	-0.0143	0.0002	0.0063	76.4690
		NUNKI	B3	DEC	-26.3217	0.0014	0.0006	0.0003	-0.0005	-26.3195
154		ZETA SGR	2.7	SHA	74.6496	0.0043	-0.0147	0.0004	0.0065	74.6400
			A2	DEC	-29.9086	0.0013	0.0007	0.0007	-0.0006	-29.9063
155		ZETA AQL	3.0	SHA	73.8663	0.0028	-0.0105	0.0004	0.0058	73.8580
			A0	DEC	13.8342	0.0013	0.0008	-0.0034	-0.0003	13.8361
156		PI SGR	3.0	SHA	72.8417	0.0040	-0.0138	0.0006	0.0060	72.8327
			F2	DEC	-21.0550	0.0012	0.0009	-0.0002	-0.0007	-21.0527
157		BETA-1 CYG	3.2	SHA	67.5117	0.0022	-0.0092	0.0011	0.0063	67.5030
		ALBIREO	*	DEC	27.9189	0.0011	0.0014	-0.0044	0.0002	27.9204
158		DELTA CYG	3.0	SHA	63.9054	0.0012	-0.0069	0.0019	0.0077	63.8955
			A0	DEC	45.0836	0.0009	0.0017	-0.0052	0.0008	45.0845

ID	NAV	NAME	MAG/SP		MEAN PLACE	H	R	S	C	APPT PLACE
					0	0	0	0	0	0
159		GAMMA AQL	2.8	SHA	63.6613	0.0029	-0.0109	0.0014	0.0055	63.6531
			K2	DEC	10.5661	0.0009	0.0017	-0.0031	-0.0001	10.5680
160	51	ALPHA AQL	0.9	SHA	62.5363	0.0029	-0.0111	0.0015	0.0055	62.5282
		ALTAIR	A5	DEC	8.8172	0.0009	0.0018	-0.0030	-0.0001	8.8192
161		GAMMA CYG	2.3	SHA	54.6138	0.0014	-0.0080	0.0028	0.0067	54.6045
			F8	DEC	40.1953	0.0006	0.0025	-0.0048	0.0013	40.1958
162	52	ALPHA PAV	2.1	SHA	53.9625	0.0065	-0.0187	0.0040	0.0093	53.9504
		PEACOCK	B3	DEC	-56.7972	0.0006	0.0025	0.0028	-0.0023	-56.7931
163		ALPHA IND	3.2	SHA	50.9417	0.0056	-0.0166	0.0036	0.0073	50.9317
			K0	DEC	-47.3589	0.0005	0.0027	0.0019	-0.0023	-47.3547
164	53	ALPHA CYG	1.3	SHA	49.8046	0.0010	-0.0074	0.0036	0.0069	49.7950
		DENEB	A2	DEC	45.2119	0.0004	0.0028	-0.0048	0.0018	45.2120
165		EPSILON CYG	2.6	SHA	48.6396	0.0018	-0.0089	0.0031	0.0058	48.6311
			K0	DEC	33.8983	0.0004	0.0029	-0.0044	0.0013	33.8988
166		ALPHA CEP	2.6	SHA	40.4688	-0.0010	-0.0045	0.0070	0.0094	40.4560
		ALDERAMIN	A5	DEC	62.5047	0.0001	0.0035	-0.0047	0.0030	62.5035
167		BETA AQR	3.1	SHA	37.3604	0.0035	-0.0122	0.0035	0.0042	37.3536
			G0	DEC	-5.6556	-0.0001	0.0037	-0.0018	-0.0008	-5.6530
168	54	EPSILON PEG	2.5	SHA	34.1871	0.0029	-0.0112	0.0037	0.0040	34.1803
		ENIF	K0	DEC	9.7872	-0.0002	0.0039	-0.0028	0.0003	9.7887
169		DELTA CAP	3.0	SHA	33.5021	0.0039	-0.0128	0.0039	0.0040	33.4955
			A5	DEC	-16.2142	-0.0002	0.0039	-0.0011	-0.0016	-16.2109
170	55	ALPHA GRU	2.2	SHA	28.2400	0.0056	-0.0150	0.0059	0.0051	28.2330
		AL NA'IR	B5	DEC	-47.0536	-0.0004	0.0042	0.0009	-0.0036	-47.0484
171		ALPHA TUC	2.9	SHA	25.6975	0.0070	-0.0167	0.0084	0.0067	25.6895
			K2	DEC	-60.3550	-0.0005	0.0043	0.0017	-0.0042	-60.3491
172		BETA GRU	2.2	SHA	19.6158	0.0055	-0.0143	0.0066	0.0041	19.6101
			M3	DEC	-46.9844	-0.0007	0.0046	0.0005	-0.0039	-46.9790
173	56	ALPHA PSA	1.3	SHA	15.8496	0.0044	-0.0130	0.0054	0.0028	15.8447
		FOMALHAUT	A3	DEC	-29.7233	-0.0009	0.0048	-0.0007	-0.0029	-29.7189
174		BETA PEG	2.6	SHA	14.2875	0.0022	-0.0108	0.0053	0.0026	14.2816
		SCHEAT	M0	DEC	27.9794	-0.0009	0.0048	-0.0030	0.0021	27.9789
175	57	ALPHA PEG	2.6	SHA	14.0471	0.0027	-0.0113	0.0049	0.0024	14.0418
		MARKAB	A0	DEC	15.1028	-0.0009	0.0048	-0.0027	0.0010	15.1033
176		GAMMA CEP	3.4	SHA	5.3613	-0.0051	-0.0068	0.0232	0.0068	5.3459
			K0	DEC	77.5264	-0.0012	0.0050	-0.0020	0.0053	77.5224

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